IRRIGATION DEVELOPMENT AND PUBLIC WATER POLICY

ROY E. HUFFMAN

Associate Professor of Agricultural Economics Montana State College

This volume deals with the economics and the social aspects of irrigated agriculture and its importance in the formulation of public water policy. Discussion ranges from the individual farm unit and the small project to the great river basin programs.

The book —

- COVERS in detail planning and organization, the techniques of financing, the methods of assessing economic feasibility, and the operation of projects, large or small.
- SUMMARIZES ably and succinctly the historical, institutional, and legal background to irrigation in the United States.
- EXAMINES without polemic or special pleading the political issues involved in irrigation development.
- CONSIDERS the broader questions of irrigated agriculture in relation to regional and national population trends and food requirements, to other natural and man-made resources, and to long-term national policy.
- DISCUSSES thoroughly the increased use of supplemental irrigation in humid areas.
- SETS FORTH the essential criteria of sound irrigation policy.

Interestingly written, this book is valuable not only to those who are in some way dependent on irrigation in the semi-arid West but also to all who are concerned with the wise use of our water resources.

ABOUT THE AUTHOR

ROY E. HUFFMAN attended Montana State College and received his postgraduate training at the Universities of Maryland and Wisconsin. Since 1946 he has taught at Montana State College where he is now Associate Professor of Agricultural Economics. Much practical experience and research have gone into the writing of this book. He has been an agricultural economist with the Great Plains Water Conservation and Utilization Program of the U. S. Department of Agriculture and was for four years Secretary of the Montana Natural Resources Council. He is a member of the Missouri Basin Regional Research Committee and the Western Water Resources Committee, Consultant to the Missouri Basin Survey Commission, and a frequent participant in conferences and meetings on the problems of irrigation and land use in the Western states.

Dr. Huffman is also author or coauthor of some twenty-five articles, research studies, and reports on various phases of the subject.

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PREFACE

This is a study of the economic and social considerations that are part and parcel of irrigation development and public water policy. No longer can an irrigation project be considered solely in terms of the engineering problems it raises. Indeed, its success depends equally upon economic feasibility and social use. Although the federal government has carried on organized activity in this field for more than fifty years, no comprehensive coverage of the problems in irrigation development has been attempted since 1927, when Ray P. Teele published his notable work on the economics of land reclamation. New concepts, new approaches and procedures, have been applied and ever more attention is being paid to the socioeconomic implications. Admittedly, the problems of irrigated agriculture and its place in public water policy are complicated and controversial; nevertheless, a full, up-to-date survey seems necessary to assess the accomplishments of the past twenty-five years.

This volume reviews past experience in the development of irrigated agriculture, and how that experience has become institutionalized in our economic, social, and legal structure. Second, it considers the many and varied phases of present-day irrigation development from the planning, organization, financing, and operation of projects and individual units to the over-all evaluation of water resource programs with their multiple uses or purposes. Third, it points out the more important considerations that are essential to sound and farsighted irrigation policy on the local, regional, and national levels.

Thus the book is suitable for college work in the economics of land, agriculture, and conservation, and it should be of value to workers in public agencies that deal with these matters. The layman may also profit from this volume, for there are several reasons why irrigated agriculture concerns all citizens and not just farmers and ranchers in the semiarid western states. Land "under the ditch" is important for the increase and stability of the nation's food production, and it competes for the available supplies of water along with the prodigious demands of industrial expansion and population

growth. Moreover, the nature and use of our water resources quite definitely involve the public interest and, hence, public participation in the formulation of water policy. The intelligent handling of our water resource problems requires an understanding of the historical, institutional, and political issues, no less than the economic and social factors associated therewith.

In writing this book I owe much to those who have contributed to my thinking on the subject, beginning with my instructors and fellow students during undergraduate and graduate training. Invaluable experience was gained from three years as an agricultural economist with the Great Plains Water Conservation and Utilization Program of the U.S. Department of Agriculture. A crystallization of viewpoint has resulted from eight years of teaching and research at Montana State College. Other research studies made in cooperation with federal agencies have served to keep me abreast of the practical problems in current work. In addition I owe much to the many persons with whom I have been associated on several statewide and regional committees for water resource development.

Grateful acknowledgment is due to several who have aided more directly in the preparation of the book. Dr. Clyde E. Stewart of the Bureau of Agricultural Economics, U.S. Department of Agriculture, and H. R. Stucky of the Montana Agricultural Extension Service reviewed the entire typescript. Valuable improvements to strengthen Chapters 2, 7, and 12 were suggested respectively by Dr. Robert G. Dunbar, Professor of History, Montana State College, by George A. Collier, Bureau of Reclamation, U.S. Department of the Interior, and by Dr. M. M. Kelso, Head of the Department of Agricultural Economics and Rural Sociology, Montana State College. Dr. Raymond J. Penn and Dr. C. W. Loomer of the Department of Agricultural Economics, University of Wisconsin, were particularly helpful with Chapter 14. Finally, I am deeply appreciative of the stenographic help and other valuable assistance provided by the Department of Agricultural Economics and Rural Sociology, Montana State College, as well as of the help and encouragement from my colleagues and students there. Errors of omission and commission remain, of course, my sole responsibility.

Roy E. Huffman

Bozeman, Montana
June, 1953

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CHAPTER 1

Irrigation Economics Comes of Age

New irrigation projects are a sort of frontier, and for many years, like other frontiers, they developed without much consideration of the economic and social problems involved. Historically, the development of new irrigation projects has been considered as a problem of concern primarily to the engineers who build them and to the individuals who settle on the farm units. Agricultural aspects of the total development problem were largely overshadowed by the engineering work involved, and the success of irrigation projects was too often measured in terms of the magnitude of the engineering obstacles overcome. A few far-sighted individuals recognized the broader nature of the problem early in the history of public irrigation development. One of them, Frederick Haynes Newell, former United States Commissioner of Reclamation, wrote more than a third of a century ago:

> Irrigation enterprises as a rule have been considered mainly from the physical or engineering side. The promoters, more concerned with irrigation developments, have approached the subject from the standpoint of the details of building the works. . . . It has been a matter of surprise for them to discover, after the works are built and are in condition for operation, that the real elements of success are those more dependent upon proper relations with the farmers and with the soil than those upon the works themselves . . .[1]

More recently, there has been a realization of the increased likelihood of success by farm operators on new irrigation projects if all phases of development are considered in detail. The blueprint of the individual farm and its place in the economy are considered to be as important as the blueprint of the dam, the pumping plant, or the canal. The modern viewpoint has been expressed this way:

> Forty years of experience has taught that the construction of project works does not complete the work of the project. . . . The

[1] Frederick Haynes Newell, *Irrigation Management* (New York: Appleton-Century-Crofts, Inc., 1916), p. 4.

> Federal Bureau of Reclamation has never lost a dam. Its engineering has been superb. It is not from the standpoint of engineering that I view this subject, but from the social and economic aspect.[2]

Recognition of the importance of the economic and social aspects in irrigation development is a result of several factors. One is the increasing complexity of our agricultural economy and our total economy. Agriculture is assuming more of the characteristics of commercial production, and the self-sufficient features of individual farms and of farming communities are passing from the American scene. In irrigation development, the type of farming must be considered in relation to the community, the region, and the nation.

Another factor is that projects now under development or proposed for construction are high-cost projects even under conditions of pre-World War II prices. In the natural course of land settlement and resource utilization, the easier to build and less costly projects were developed first. Although society may be expected to assume part of the burden of irrigation development because of associated features of public value, there are still many problems to be solved in connection with the farmer's place in a repayment program. It is increasingly important to know the ability of the farm operators to carry their share of the costs.

A third factor to be considered is that most new projects are a part of multiple-purpose developments. Repayment obligations must be divided among all those benefiting from the development, which may have the following objectives: irrigation, flood control, navigation, hydroelectric power, industrial and domestic water use, sanitation and pollution abatement, wildlife conservation, and recreation. In some instances, irrigation may be a virtual by-product of one or more of the other uses.

A fourth complicating factor of great importance is that irrigation development is being carried into the "twilight zone" between the semiarid regions and subhumid regions on a scale never before considered. Most of past irrigation development has been on arid lands where the alternatives to irrigated agriculture were limited or nonexistent. A considerable amount of future irrigation development is proposed for lands where alternatives to irrigated agriculture, primarily wheat production, are of importance. This raises new

[2] Raymond F. Lund, "Perplexities Unlimited," *Reclamation Era*, XXXIII, No. 12 (December, 1947).

problems regarding the extent to which such development may be justified.

Irrigation development is one part of the broader field of land reclamation. Irrigation of new lands should be studied in its relation to other types of land reclamation including drainage, land clearing, and rehabilitation of agricultural lands which have eroded or otherwise lost their productivity. To the extent that public funds are used, society is entitled to assurance that land reclamation is carried on where it will realize the greatest return per dollar spent.

In turn, land reclamation is one phase in the determination of a national land policy for the optimum utilization of human and natural resources. The possibilities for land reclamation, of which irrigation development is one, should be reviewed in the light of population trends and food requirements, technology in agriculture, and the current goals of domestic and foreign policies of the United States. In other words, irrigation is important enough in the natural resource picture to merit a settled, long-run policy, subject, of course, to such review and modification as changing conditions indicate desirable. Public policy toward irrigation should be of a more stable character than it has been during the past twenty years when emphasis shifted from combating drought conditions to adding to the food supply for World War II to supplying farming opportunities for returning veterans. Irrigation development is a long-run process and, in most instances, cannot be based on such short-run expedients as those just mentioned. Public irrigation policy should be an integral part of long-range economic and social policy.

Economic and social policies intended to provide a healthful climate for the establishment and growth of private enterprise have been formulated throughout the history of the United States. Land grants to railroads, protective tariffs, tax favors, and many types of subsidy have been basic factors in the development of the American economy. The expenditure of public funds for the development of irrigated agriculture and associated water uses has been and is now consistent with the long existing governmental effort to provide a constantly expanding resource base upon which private enterprise can build. There are major questions, however, regarding alternatives of time and place for such public investments.

It is evident that present-day irrigation development is a problem of great scope and complexity. The problem is a dynamic one, but

at the same time the flexibility of both public and private action is limited by many factors which have become institutionalized in the economic, social, and legal structure of the nation. In view of the absence of an up-to-date discussion of the subject, the many new concepts which dominate water resource development, and the new maturity of the socio-economics of irrigation, it seems appropriate that a comprehensive treatise be prepared. It is the purpose of this study to review the past experience in the field, to consider the many and varied phases of present-day irrigation development, and to point out some of the considerations essential to a sound irrigation policy.

CHAPTER 2

A Brief History of Irrigation

Wherever in the arid and semiarid regions of the world evidence has been unearthed of the activities of man through the ages, there, also, remnants of irrigated agriculture have been found. No one can tell whether irrigation originated in Asia, Africa, Europe, or America, for the artificial application of water to crops has long been known on all continents. It is written in the Bible:

> And a river went out of Eden
> to water the garden; and from
> thence it was parted, and
> became into four heads.
> (Genesis 2:10)

The Antiquity of Irrigation

The science of irrigation is believed by some students of history and literature to have been known in prehistoric times. Plato's writings include a detailed description of an elaborate and extensive system of irrigating canals in the sunken island of Atlantis. If this legendary island existed, irrigation was in practical use more than 12,500 years ago.[1] Plato received his information from the writings and sayings of one of his ancestors who studied the early history of Egypt and became convinced that the Egyptians constituted one of the earliest and largest colonies which had gone out from the land of Atlantis.[2]

Many of the early Egyptian rulers were instrumental in the development of technical knowledge in the field of irrigation. The fertility for which Egypt was known throughout the recorded past must be attributed to the utilization of the waters of the Nile for irrigation. In about 2000 B.C., the Nile was diverted through a

[1] Lute Wilcox, *Irrigation Farming* (New York: Orange Judd Co., 1895), p. 1.

[2] Clesson S. Kinney, *A Treatise on the Law of Irrigation* (Washington, D.C.: W. H. Lowdermilk & Co., 1894), p. 15.

channel twelve miles long into Lake Moeris. During flood periods, excess river waters were stored in the lake; in times of drought, the lake waters irrigated adjoining farm lands.[3] Thus we find record of what was probably the world's first artificial lake and storage reservoir for irrigation water. Other irrigation developments in which Egypt was first include the artesian well, the milometer for gauging streams, and great canal systems for both irrigation and navigation.

In Egypt, also, the earliest known mechanical aids for lifting water from one level to another were developed. The simplest method was the use of waterproofed baskets to lift water from a stream into an irrigation ditch. A more complicated device used in Egypt and India was the "shadoof." It consisted of a pole balanced on a crossbeam with a bucket at one end and a counterweight at the other. The counterweight eased the labor of lifting the water to a higher level. Sometimes a number of "shadoofs" were used in a series when the height of lift was too great for one. This ancient device is still in daily use in the valley of the Nile.[4]

Other mechanical devices in use early in the history of irrigation include water wheels rotated by the current of moving streams, water wheels driven by man power or animal power, a trough equipped with paddles on an endless belt and powered by a man on a treadmill, and a screw rotating in an enclosed cylinder.

Kinney states that the public irrigation works in Egypt which have been judged the earliest are on a much greater scale and more perfect than the later ones. This would indicate that the Egyptians reached the zenith in irrigation development prior to modern recorded history.[5] Westermann concluded that the primitive and unregulated methods of using flood waters must have been abandoned in the Pyramid Age (3000 to 2500 B.C.) of Egyptian history. It was then that the Pharaohs were able to organize the labor of Egypt and to concentrate it upon a large enterprise. Also, the period saw rapid advances in technical skills. That the organized effort associated with pyramid building was extended to other activities including irrigation is indicated by the existence of the official position of "superintendent of the irrigated lands of the Pharaoh."

[3] Wilcox, *op. cit.*, p. 2.
[4] *Supplemental Irrigation* (New York: Johns-Manville Corp., 1945), p. 5.
[5] Kinney, *op. cit.*, p. 13.

Later, in 945–924 B.C., there is record of an official with the title "chief of irrigation." By about 2000 B.C., the apportionment of irrigation waters to various districts was set forth in written records.[6]

Much of the success of the Babylonian Empire more than four thousand years ago was due to a stable and productive agriculture based on irrigation. Hammurabi, great builder of the Babylonian Empire, counted the extensive irrigation systems among his proudest accomplishments. Records have been unearthed expressing his personal pride in having "changed desert plains into well-watered lands." The ancient works of Babylonia included a lake 42 miles in circumference and 35 feet deep to store the flood waters of the Euphrates River for irrigation.[7] The great Nahrawn Canal which diverted water from the Tigris River was more than four hundred miles long, varied in width from two hundred and fifty to four hundred feet, and was used for both irrigation and navigation.[8]

The development of urban communities presupposes a division of labor where food supplies for the city dwellers are provided by a productive agriculture. In such arid regions as that occupied by the Babylonian Empire, only irrigated agriculture could have produced a continuous and sufficient supply of food for centers of population as large as the cities of Babylon and Ur. Statements of governmental interest and activity in irrigation development and in the regulation of water use are found throughout the historical records of ancient Mesopotamia. The Babylonian Empire was approximately identical in geographical area with the southern portion of Mesopotamia.[9]

Semiramis, until recently considered a legendary Assyrian queen, appears in Babylonian history about 1,200 years after Hammurabi. She also evidenced considerable pride in the irrigation developments under her regime. The proclamation on her tomb reads: "I constrained the mighty river to flow according to my will and led its waters to fertilize lands that had before been barren and without inhabitants."

[6] W. L. Westermann, "The Development of the Irrigation System of Egypt," *Classical Philology*, XIV, No. 2 (April, 1919), 158–64.

[7] Charles F. Davis, *The Law of Irrigation* (Denver, Colo.: Publishers Press Room & Bindery Co., 1915), p. 8.

[8] Wilcox, *op. cit.*, p. 5.

[9] Jacob W. Gruber, "Irrigation and Land Use in Ancient Mesopotamia," *Agricultural History*, XXII, No. 2 (April, 1948), 69–77.

Great irrigation works were developed in Persia during the rule of Darius some five hundred years before Christ. The method used to bring water to lands where no streams or other water supplies were available is a first class engineering marvel by any standards. Tunnels were dug for many miles into the surrounding mountains to tap underground sources from which the water flowed by gravity. These tunnels or "kanats" often extended hundreds of feet below the surface. All digging was done by hand and vertical shafts or wells were dug at frequent intervals so that excavated material could be removed. "Kanats" are still constructed and used in Iran (formerly Persia) in much the same way as they were twenty-five hundred years ago.[10]

Irrigation structures in China and India are probably as ancient as those in Egypt. At first, irrigation in China was limited to the delta lands of the Yellow River, but as more complicated systems were devised, irrigation was extended to other arable lands. The most extensive irrigation systems were planned by Li Ping, governor of Chengtufu, in the third century before the Christian era, and completed by his son. The Imperial Canal is one of the greatest works of all time, being 700 miles long and usable for both irrigation and navigation.[11]

The importance of a productive irrigated agriculture as the strategic factor in the growth of the government's economic function is also noted in connection with ancient China. As in the case of Egypt and Babylonia, the construction of enormous public works like the Great Wall of China required an agriculture which had progressed beyond the subsistence stage. Direction of agriculture to support the public works goals involved control in varying degrees over the land, the man power, and the water supply. Control of the water supply for irrigation and transportation inevitably led to the growth of bureaucracy and economic control.[12]

Large-scale reservoirs and irrigation canals were constructed in India many centuries prior to the Christian era. By 300 B.C., India had developed irrigation to a point where reports on the advantages of growing two crops a season on irrigated lands became a part of written history.

[10] *Supplemental Irrigation, op. cit.*, p. 2.

[11] Davis, *op. cit.*, p. 8.

[12] John King Fairbank, *The United States and China* (Cambridge, Mass.: Harvard University Press, 1948, pp. 54–55.

Irrigation Turns Westward

Irrigation spread westward rapidly from the locality of its probable inception. The Phoenicians had constructed many canals as early as 1500 B.C. The first invaders of the North African shore reported large gardens and plantations plentifully watered by means of canals. Irrigation development was especially advanced in Tunis and Algeria. Great canals supplied drinking water to Carthage.[13] Kinney suggests that, in all probability, Egypt taught irrigation to the other nations of the Mediterranean area.[14]

As early as the first century A.D., the Romans practiced irrigation on an extensive scale. The importance of irrigation in the Roman economy is indicated by the attention given irrigation in the famous codes of law formulated in the fifth and sixth centuries after Christ. Certain hours of the day were specified when water from the famous Roman aqueducts could be used for watering of gardens and farms in much the same way that many present-day American cities establish irrigation hours. Also, as is characteristic of many of our cities today, considerable difficulty was experienced in getting some water users to comply with the regulations.[15]

Julius Caesar took the practice of irrigation with him wherever he went in the process of conquering and colonizing. Irrigation was fostered in all the Mediterranean countries with many remains still in evidence. A type of flood irrigation of grassland was introduced into England by the Romans and is still practiced along the Avon River.[16]

Greece also paid considerable attention to the development of water resources. Masonry aqueducts were numerous and one canal included a mile-long tunnel through a hill.[17]

The Arabs were among the leaders in spreading knowledge of irrigation, and it was an Arabian people, the Moors, who introduced irrigation into Spain when they invaded that country. The Moors developed extensive irrigation systems in Spain during the tenth century A.D., with the result that some of the most arid regions of the country became her most productive.[18]

[13] Davis, *op. cit.*, p. 9.

[14] Kinney, *op. cit.*, p. 16.

[15] *Supplemental Irrigation*, *op. cit.*, p. 4.

[16] *Ibid.*, p. 4.

[17] Davis, *op. cit.*, p. 9.

[18] *Supplemental Irrigation*, *op. cit.*, p. 5.

The Spanish rulers continued the use of irrigation after the Moorish invaders were driven out and constructed some of the largest projects known at that time. Among them was a dam measuring 140 feet in height and 190 feet in width across a narrow gorge of the Monegre River in the province of Alicante.[19] Many great canals were built which have endured to the present time, particularly those in the province of Granada.

Irrigation was practiced extensively in Italy and France from the eleventh century on, with Italy becoming a leader in the intelligent development of proper irrigation practice during the seventeenth century.

Early Irrigation in the Americas

On both the North and South American continents, the practice of irrigation flourished before the time of Christ. The Incas had developed a civilization of considerable magnitude in Peru long before the Spaniards under Pizarro arrived and laid waste the land in their mad search for gold. An important feature of the Inca culture was the gigantic irrigation structures which dated back to the first traditions of the native population. Prescott, in his *Conquest of Peru,* writes of the great antiquity and quality of the irrigation structures to be found, including stupendous irrigation canals—one being more than 400 miles in length. The Incas grew a variety of crops in their mountain valleys and the refinements of their irrigation practices were probably superior to any others known. Some students of Inca civilization are of the opinion that the present inhabitants of the land cannot be descendants of the Incas but represent a later migration. It is inconceivable to them that present practitioners of the crudest kind of irrigation could be descendants of a race which was a master of the art of irrigation and builders of huge works. Some of the aqueducts were of great length and involved considerable knowledge of engineering.[20]

Another Spanish conqueror, Cortez, reached the high plateau of central Mexico to find an advanced agricultural civilization based upon extensive and skillful irrigation. Remains of irrigation structures on the same vast scale are also to be found in Chile and Argentina.

[19] *Ibid.*, p. 5.

[20] Kinney, *op. cit.*, p. 18.

There are also remains of irrigation structures in New Mexico and Arizona which indicate the antiquity of irrigation in the United States. The existing ruins of many ancient towns and irrigation systems in these two states indicate that at one time a dense population occupied the area under an advanced form of government. Although these great developments had been abandoned and the inhabitants had vanished, the Spanish explorers who came into the area found that the Indians irrigated their crops from the Rio Grande River and that, throughout the arid regions of the Southwest, the Pueblo Indians had built a community existence based on irrigation.

The vanished civilization in the Southwest has been referred to as the only "true irrigation culture in prehistoric North America." [21] It has been estimated that the canals and laterals exceeded 1,000 miles in length and that the area irrigated in the Salt River Valley approximated 250,000 acres. One canal has a drop over rock of forty or fifty feet and is worn to an extent that would require centuries of water action.[22] Some of the canals were reclaimed and used again. Mormon settlers began clearing ancient canals in the Salt River Valley in the 1870's.[23]

Early explorers in the region inquired of the Pima Indians regarding the identity of the canal builders. The Pimas referred to the ancient people as "Hohokam" meaning in their language "those who have vanished." The extensive canal system had been abandoned as far back as Pima tradition carried. The Hohokam people are believed to have come into south-central Arizona about the beginning of the Christian era and to have disappeared from the region about 1400 A.D., more than a century prior to the arrival of the Spanish explorers.[24]

Widtsoe classifies irrigation history in the United States into three periods—the prehistoric, the prepioneer, and the modern.[25] One more instance should be noted in the prehistoric period. A

[21] Odd S. Halseth, "Arizona's 1500 Years of Irrigation History," *Reclamation Era*, XXXIII, No. 12 (December, 1947).

[22] Kinney, *op. cit.*, p. 21.

[23] Henry C. Shetbone, "A Unique Prehistoric Irrigation Project," *Annual Report of the Smithsonian Institution*, 1945, pp. 379–86.

[24] *Ibid.*

[25] John A. Widtsoe, "History and Problems of Irrigation Development in the West," *Proceedings of the American Society of Civil Engineers*, March, 1926, pp. 396–402.

successful irrigation economy had been developed by the Indians in Kansas by 1650, but only ruins remained when the white man arrived.[26]

The prepioneer period in irrigation history refers to the dissemination of irrigation practices throughout the Southwest and into California by the Spanish missionaries of the Roman Catholic Church. They established missions in Arizona, New Mexico, and California, around which were built small irrigation systems. About 1776, the Spanish government undertook to build an irrigation community near the present site of Santa Cruz, California.[27] The mission at San Diego was established in 1769 and included an irrigation system.[28] It was the practice of the missionaries to develop an agricultural community in which the Indians were taught the ancient art of irrigation.

Modern Irrigation in the United States

The agricultural settlement and expansion period in the United States saw no utilization of irrigation until the Mormon pioneers established themselves in the arid valley of Great Salt Lake in 1847. Prior to that time, the settlers of the new continent had been busily engaged in the humid portions of the country to the east. Those who did venture across the "Great American Desert" continued on to the areas of the Pacific Coast where the rainfall was quite as heavy as in the eastern United States.

William A. Smythe points out that the Anglo-Saxon never concerned himself with irrigation in a large way until he found it a necessary tool in the settling of western America as well as portions of Australia and South Africa.[29] Prior to the last half of the nineteenth century, the art of irrigation had been the exclusive possession of the Indian, Latin, and Asiatic races. Irrigation as practiced by the American Indians was of the crudest type, and the white settlers recognized at an early date the need for improvements in techniques.

[26] William C. Brady, "Kansas Pioneers in Irrigation," *Reclamation Era*, XXXIV, No. 6 (June, 1948).

[27] Widtsoe, *op. cit*. See also George Thomas, *Early Irrigation in the United States*, University of Utah, 1948, for discussion of the Spanish missionary influence in the southwestern United States.

[28] Kinney, *op. cit*., p. 30.

[29] William A. Smythe, *The Conquest of Arid America* (rev. ed.; New York: The Macmillan Co., 1905), p. 335.

The Mormon pioneers are generally credited with the founding of modern irrigation in the United States, although there have been other contenders for the honor. One writer would give the credit to Dr. Marcus Whitman and his mission near the present city of Walla Walla, Washington.[30] Whitman established the mission in 1837. Irrigation of gardens had been practiced by the Hudson's Bay Company at Fort Walla Walla between 1830 and 1840.[31]

Thomas states that the Mormons were well informed regarding the arid character of the country to which they proposed to migrate and learned all they could about irrigation before the journey began. The council of Mormon leaders discussed irrigation in their winter quarters during the months preceding the westward movement in the spring of 1847. It is thought, too, that some of the Mormon men may have worked as freighters or teamsters on the wagon trains between Independence, Missouri, and Santa Fe, New Mexico. They would have had an opportunity to observe irrigation at first hand in Santa Fe where it was a common practice.[32] Utah's claim to the title of "Cradle of American Irrigation" is based, not on the date of the initial irrigation, but on the institutions of modern irrigation that were first developed there. Dr. John A. Widtsoe expressed it this way:

> The Mormon pioneers, who entered the Great Salt Lake Valley in 1847, belonged to the civilization that Anglo-Saxon peoples had won for themselves through centures of struggle. The gains of that civilization they must maintain. The stark desert must be subdued, but not at the price of civilized life and living. Somehow, they must hold on to the social, economic and spiritual possessions on the conquered desert as well as they had in humid regions. That was the challenge to the pioneers of 1847—to build communities of modern, civilized people under the ditch, comparable or superior to those in the rainfall regions from which they came. That accomplishment is in mind when we speak of modern irrigation.[33]

Another important irrigation development was undertaken in February, 1857, when a group of San Francisco Germans formed the

[30] Robert W. Fisher, "Who Started It?" *Reclamation Era*, XXXIII, No. 6 (June, 1947).

[31] George Thomas, *Early Irrigation in the Western States*, University of Utah, 1948, p. 50.

[32] *Ibid.*, pp. 53–55.

[33] John A. Widtsoe, "A Century of Irrigation," *Reclamation Era*, XXXIII, No. 5 (May, 1947).

"Los Angeles Vineyard Society" for the purpose of establishing a colony near Los Angeles, California. The site selected was twenty-eight miles southeast of Los Angeles on the Santa Ana River. The settlement, which was named Anaheim, was carefully planned and laid out before the land units were occupied. Certain lots were set aside for community purposes and the rest subdivided and planted with young vines. The individual lots of 20 acres each were distributed to the shareholders in the colony by means of a lottery. Those who drew the more valuable lots paid an additional sum into the common treasury, and those to whom the less valuable lots had fallen were compensated. Once the homesteads had been allotted, the cooperative nature of the venture ceased and the Los Angeles Vineyard Society was dissolved. After a quarter of a century of existence, the vineyards were destroyed by a strange disease and the pioneers turned to the growing of oranges and walnuts. The Anaheim settlement became the model for the other colonies of the Los Angeles area.[34]

The Union Colony founded at Greeley, Colorado, in 1870 was of major importance in modern irrigation development in the United States. It was organized under the leadership of N. C. Meeker who was familiar with the experience of the Mormon pioneers. The Colony received much publicity through the columns of Horace Greeley's *New York Tribune* and the town was named for Mr. Greeley.[35] The Union Colony was important because it proved that the method of settlement developed in Utah provided a sound foundation for the establishment of new irrigation ventures on a community basis.[36] The Utah development was the result of a religious emigration, while the settlement at Greeley, Colorado, was the New England town meeting transplanted.[37] The Union Colony was so successful that other projects were soon founded at Boulder, Longmont, Fort Collins, Loveland, and Colorado Springs in Colorado.

Once modern irrigation had proved itself in Utah and had been

[34] Erwin G. Gudde, "Anaheim—The Mother Colony of Southern California," *The American-German Review*, VII, No. 6 (August, 1941), 4–6.

[35] See David Boyd, *A History: Greeley and the Union Colony of Colorado* (Greeley, Colo.: The Greeley Tribune Press, 1890).

[36] John A. Widtsoe, *The Principles of Irrigation Practice* (New York: The Macmillan Co., 1914), pp. 461–62.

[37] Elwood Mead, *Irrigation Institutions* (New York: The Macmillan Co., 1903), p. 44.

further demonstrated in California and Colorado, it spread rapidly to the other western states. The continued expansion of irrigation into new areas and the placing of additional lands under the ditch created great interest throughout the nation. The result was a series of legislative acts: attempts by Congress to formulate an acceptable and workable program in aid of irrigation development.

CHAPTER 3

Irrigation in Public Land Policy

As the settlement of the western United States gathered speed, the demands for free grants of land by the government to the settlers culminated in the Homestead Act of 1862. Within a very few years, it became evident that this law was not suited to the arid lands of the West. By 1869, Utah was asking for land to be used in promoting irrigation development and was trying to secure the necessary legislation from Congress.[1] The irrigation-minded people of Utah and the supporters they acquired throughout the arid states found it a difficult problem to achieve their goal with respect to federal aid to irrigation. Many people, both in and out of Congress, felt that the land laws were perfect as they were; others felt that those asking for a change were trying to make a land grab. Many were so ill informed regarding the western portion of the United States as to believe that the fertile lands and subhumid climate of Iowa extended unbroken to the Pacific Ocean. A majority of the members of Congress seemed to have a deep-seated aversion to change of any kind.

It became increasingly evident that the land problems of the western portion of the nation were no nearer solution, and in 1875 President Grant visited the arid regions. As a result of his trip, the President recommended to Congress that a commission be created to study the changes needed in disposition of public lands.[2] About this time, the Commissioner of General Land Office recommended that the public domain west of the hundredth meridian be sold freely at a price set by the government instead of being restricted to the pre-emption and homestead requirements. The recommendation for cash sale was supported by the argument that irrigation development required large amounts of capital and that title to the

[1] B. H. Hibbard, A *History of the Public Land Policies* (New York: Peter Smith, 1939), p. 424.

[2] *Ibid.*, p. 425.

land was essential in order that it might be used as security in obtaining the necessary financing.[3]

The Desert Land Act

The drive for legislation to use the disposal of public lands as an aid to irrigation development produced concrete results with the passage of the Desert Land Act in 1877. By terms of the new law, a settler might purchase one section (640 acres) of land if he agreed to irrigate it within three years of filing. The settler paid twenty-five cents per acre at the time of filing his application and paid an additional dollar per acre upon proof of compliance. Final compliance with the law could be proved at any time within three years, at which time the settler was given title to the land. Only one entry per person was permitted, and no assignments of rights were allowed.[4]

Extensive use was made of this new method of acquiring land from the public domain. More than a quarter of a million acres were entered under the law within three months after its passage. Land continued to be entered at a rate of between half a million and a million acres per year. Abuses of the law were numerous. The law was widely used by interests in the eastern states to enter land and hold it for speculative purposes. Large livestock ranches used it as a means of retaining control of grazing lands bordering a water supply.[5] The law was not clear as to how much water must be conducted to the land, and many irrigation canals were no more than plow furrows. The author is familiar with one tract of land acquired under the Desert Land Act where the irrigation ditch is a plow furrow beginning at a "storage dam" about two feet in height on a dry stream bed and ending on a hill at a point some twenty-five or thirty feet higher than the "water supply."

The Desert Land Act was modified by Congress in 1890. Serious questions had been raised as to why a settler should be permitted to enter 640 acres for purposes of irrigation farming when the Homestead Act allowed only 320 acres for dry farming or stock raising. At the time the Desert Land Act was passed in 1877, it was

[3] *Ibid.*, p. 426.

[4] Roy M. Robbins, *Our Landed Heritage* (Princeton, N.J.: Princeton University Press, 1942), p. 219.

[5] Hibbard, *op. cit.*, p. 429.

believed the larger acreage would prove an inducement to irrigation not afforded by quarter- or half-sections.[6] In later years, however, it became difficult to reconcile this theory with the obvious fact that less irrigated land was required for an adequate farm unit. The changes in the Desert Land Act restricted to 320 acres the amount of an entry and required improvements of three dollars per acre; that is, one dollar per acre per year, for three years, was to be put into the land toward its reclamation. In addition, water must be available for the entire acreage and one-eighth of the tract had to be put under cultivation. Provision was also made for settlers to associate together in projects for irrigating several entries. This Act, recognizing for the first time that water could not be conducted directly to each tract, reserved a right of way for ditches or canals constructed by the authority of the United States across patented lands. Finally, only citizens of the state in which the land was located were privileged to enter land under the amended Desert Land Act.[7]

Abuses of the Desert Land Act continued to be numerous despite the modifications of 1890. President Theodore Roosevelt appointed a commission in 1903 to investigate the effectiveness of irrigation development under the law. The report of the commission indicated the many ways in which the Desert Land Act had been and was being used to build up landed estates. A man and his wife could each enter 320 acres of land. Employer-capitalists could supply each of their employees with money to enter a claim and, when title was secured, take over by "purchasing" the various entries. Numerous companies were formed with 320 acres entered in the name of each "company." The requirement regarding improvements was also circumvented by various means. Stock in proposed irrigation companies as well as projects having no direct relation to the irrigation development, such as fencing, were included as meeting the improvement stipulation. The commission also raised questions as to why entry of land was permitted under both the Homestead and Desert Land Acts and why residence was not required under the Desert Land Act as under the Homestead Act.[8]

[6] *Ibid.*, p. 427.
[7] *Ibid.*, p. 431.
[8] *Ibid.*, p. 433.

The Carey Act

The West was agreed that a new approach to land reclamation was needed. A number of individuals, including the United States Surveyor General of Idaho, urged in 1889 that irrigation development be taken over by the federal government or the states. A memorial to Congress from Nebraska in 1891 asked that body to take charge of irrigation development. The demand for cession of arid lands to the states in which they were situated was supported by congressmen from Idaho, Wyoming, and Nebraska. About the same time, the Commissioner of the General Land Office recommended that the lands be turned over to the states for development because he believed that Congress would not formulate an effective plan of federal action.[9]

Thus Congress found itself faced with conflicting demands for federal irrigation development and for state jurisdiction in the matter. The West was fairly well agreed that they wanted the federal government to cede the lands to the states. This attitude was emphasized by a series of National Irrigation Congresses, the first in Salt Lake City in 1891 and the second in Los Angeles in 1893. At both these meetings cession of the lands to the states was urged.[10] There was no organized opposition in the East, and the stage was set for the Carey Act.

The period between the enactment of the Desert Land Act in 1877 and the passage of the Carey Act saw the promotional enthusiasm regarding irrigation development fanned to great heights. Land companies and railroads advertised widely and issued illustrated material extolling the great productivity of irrigated lands. Magazine articles and books on the subject were numerous. Individuals made it their life-work to promote irrigation development with all the zeal of evangelists.[11] The result was a widespread, and often unquestioning, endorsement of reclamation which gave legislators from the western states the support they needed in their campaign for new legislation. Indeed, the promotional approach which

[9] *Ibid.*, p. 432.

[10] Robbins, *op. cit.*, p. 328.

[11] It is possible that William E. Smythe was the most fervent of all the irrigation evangelists. His book, *The Conquest of Arid America* (New York: The Macmillan Co., 1905), contains such chapter titles as "The Better Half of the United States," "The Blessing of Aridity," and "The Miracle of Irrigation."

evolved during the 1880's has continued to play an important part in public consideration of land reclamation problems to the present time.[12]

The Carey Act was passed in August of 1894 and was named in honor of its author, Senator Joseph Carey, Chairman of the Senate Committee on Public Lands. This legislation aimed to encourage the investment of private capital by providing that cost of reclamation could be made a lien on the land. The Federal Congress left to the individual states the implementing of this provision of the Act, but none of the states did so.[13]

The Act provided that the government donate to certain states an amount of land not to exceed 1,000,000 acres each. For their part in the arrangement, the states were to cause the lands to be settled, irrigated, and a portion of them cultivated. When the provisions of the Act had been complied with, the federal government was to grant patents to the state or direct to the assignees of the state.[14]

The Carey Act was not specific in stating the method of development to be used. The general plan has been for the states to contract with private construction companies for the building of irrigation works. The construction companies sell water rights to reimburse themselves for the cost of construction. The states are prevented by terms of the Act from disposing of the lands or using them for any purpose other than that of securing their reclamation, cultivation, and settlement. Not more than 160 acres may be sold to any one person, and the sale may be made only to parties who have contracted for the purchase of water rights. In this way, the land and the water are tied together.[15]

The financial provisions of the Carey Act are its weakest points. The settlers cannot obtain title to the land until they can show actual irrigation. Until they get title, their notes are not liens on the land and the bonds issued are not secured by the land. Because Carey Act projects were developed under federal and state laws, however, many construction companies represented their bonds as

[12] Ralph H. Brown, "Utilization and Conservation of Our Arid and Semiarid Lands," in *Our Natural Resources and Their Conservation*, edited by A. E. Parkins and J. R. Whitaker (New York: John Wiley & Sons, Inc., 1939), p. 123.

[13] Ray P. Teele, *The Economics of Land Reclamation in the United States* (Chicago: A. W. Shaw Co., 1927), p. 67.

[14] Hibbard, *op. cit.*, p. 436.

[15] Teele, *op. cit.*, p. 67.

being liens on the land.[16] Many people feel that it was a mistake to make the construction companies middlemen in the delivery of water because they must show a high rate of profit in order to attract capital. The water user on the project would of course be the one who paid in higher costs.

The original grants of 1,000,000 acres to each of ten states were supplemented by additional grants of land to states registering them. Table 1 shows the acreages which have been segregated and patented in each of the ten states coming under the provisions of the Carey Act.

TABLE 1

AREA OF LANDS SEGREGATED AND PATENTED UNDER THE CAREY LAND ACTS [a]

State	Total Area Segregated (acres)	Total Area Patented (acres)
Arizona	13,745.16	
Colorado	284,653.97	37,706.47
Idaho	1,335,787.59	636,204.87
Montana	246,698.97	92,280.00
Nevada	36,808.59	1,578.60
New Mexico	7,604.78	4,743.33
Oregon	388,876.87	73,442.08
Utah	141,814.94	37,239.98
Washington		
Wyoming	1,441,869.17	202,370.96
Total	3,897,860.04 [b]	1,085,566.29 [c]

[a] Acts of August 18, 1894 (28 Stat. 372–422), and March 15, 1910 (36 Stat. 237, 43 U.S.C. sec. 643).
[b] 74,599.18 acres were still segregated June 30, 1947, as follows: 14,135.03 acres in Idaho and 60,464.15 acres in Wyoming.
[c] Does not include 89,665.47 acres reconveyed as follows: Idaho, 59,460.65 acres; Montana, 10,264.03 acres; Oregon, 14,843.56 acres; and Wyoming, 5,097.23 acres.

Source: U.S. Department of the Interior, Bureau of Land Management, Annual Report of the Director, 1947.

An amendment to the Carey Act passed in 1921 authorized the Secretary of the Interior to restore segregated lands to the public domain unless actual construction work on reclamation had been started within three years after segregation. The amendment further provided that, if an irrigation system had been constructed, the

[16] *Ibid.*, p. 68.

land could be returned to the public domain if not actually irrigated in ten years.[17]

The Carey Act was designed so that the irrigation systems might be cooperatively owned and controlled. When a project was completed and the lands and water rights had been paid for, stock in the company which was to own and operate the enterprise was issued to the holders of the water rights. Such developments were financed primarily by the settlers. Even in cases where promoters in search of quick profits were involved, the major part of the money was advanced by the settlers. Where developments failed, the promoters, as is customary, lost little of their own money.[18]

Reclamation Act of 1902

Neither the Desert Land Act nor the Carey Act had produced a satisfactory irrigation development program in the West by the turn of the century. The National Irrigation Congress had continued to hold annual meetings, and by the time the Ninth Irrigation Congress met in 1900 it had shifted its support to a program of reclamation by the federal government. Advocates of federal participation in reclamation had the following objects in mind: [19]

1. To develop and utilize resources then unused.
2. To provide new homes on the land for citizens.
3. To provide food for a rapidly expanding population.
4. To settle the vast arid region between the Midwest and the Pacific Coast in order to reduce costs of transportation through increased railroad tonnage.
5. To supply agricultural development for existing mining and forest industry as well as future industrial and commercial development.

The federal government had previously made some surveys directly concerned with irrigation. Under provisions of the Act of October 2, 1888, the U.S. Geological Survey made studies to determine the extent to which the lands of the arid region could be reclaimed by irrigation. For a quarter of a century prior to 1900, the Congress of the United States had been faced with an increasing demand that the federal government take charge of irrigation

[17] Hibbard, *op. cit.*, p. 439. [18] *Ibid.*, pp. 438–39.
[19] *Ibid.*, p. 440.

development. Opponents of federal participation in irrigation development listed as their principal arguments: [20]

1. That the federal government had failed with the forestry program and thereby demonstrated its ineptness in resource conservation.
2. That the federal government was too far away from the arid West to do a satisfactory job.
3. That there was too much variation in the regions to be irrigated for one federal program to be satisfactory.
4. That it was not fair to tax one group of citizens for the benefit of another.
5. That agriculture in the eastern states would suffer as a result of competition from newly irrigated areas in the West.
6. That irrigation development would involve a terrific expense and was in reality a raid on the treasury.

The pressure for federal action received its greatest impetus when Theodore Roosevelt became president in 1901. There was a growing awareness of the need for conservation and the Reclamation Act was signed on June 17, 1902, after a bitter congressional battle. The Reclamation Act is often called the Newlands Act in honor of its author, Senator Francis Griffith Newlands, of Nevada. Among its important original provisions were: [21]

1. Establishment of a reclamation fund from the sale and disposal of public lands to be used in developing irrigation projects.
2. Agreement by the settler to repay the cost of construction in not more than ten annual payments, to meet the residence requirements of the Homestead Act, and to reclaim at least half of the total irrigable area of his entry.
3. The selling of water rights to private owners of land but not more than 160 acres to an individual, and in no case to nonresidents of the state in which the project was located.
4. Apportionment of the reclamation fund during each ten-year period to the several states on the basis of income from public land sales within the states.[22]

[20] *Ibid.*, pp. 439–42.

[21] U.S. Department of the Interior, Bureau of Reclamation, *Federal Reclamation Laws Annotated* (Washington, D.C.: Government Printing Office, 1947), pp. 16–77.

[22] The section of the Reclamation Act of 1902 dealing with allocation of funds was repealed in 1910 at the time the reclamation fund was enlarged by an advance of $20,000,000 from the Treasury.

There is some disagreement as to whether or not the Reclamation Act of 1902 was a conscious move in the direction of the conservation of natural resources. Brown wrote that, in the beginning, the Act was a home- and community-building measure, not a conservation policy.[23] It has been described as having been based on a "happy home" philosophy.[24] The 160-acre limitation on size of units was designed to give opportunities to a large number of people and achieve a wide diffusion of ownership.

Webb points out that it was President Roosevelt's active intere and influence which made passage of the Reclamation Act possibl Senator Newlands, author of the bill, was a Democrat and its passage in the House had been prevented by eastern Republicans until Roosevelt induced them to relax their opposition.[25] It is certain that Roosevelt had a better understanding of the problems and needs of the arid and semiarid West than any previous President. He had ranched for several years along the North Dakota-Montana border during his quest for health as a young man.[26] It is obvious, too, that President Roosevelt considered land reclamation among the most important problems of his administration. He wrote in his autobiography, "The first work I took up when I became President was the work of reclamation." [27] His position was stated in no uncertain terms in his message to Congress on December 3, 1901, shortly after he succeeded McKinley in the presidency. He said, "It is as right for the National government to make the streams and rivers of the arid region useful by engineering works for water storage as to make useful the rivers and harbors of the humid region by engineering works of another kind." [28] Peffer states that Roosevelt's conservation program radiated from two central points, homes and forests, with his sponsorship of reclamation stemming from the fact that it would expand the opportunities for homes.[29]

[23] Brown, *op. cit.*, p. 127. [24] Hibbard, *op. cit.*, p. 449.

[25] Walter Prescott Webb, *The Great Plains* (Boston: Ginn & Co., 1931), p. 362.

[26] Smythe, in *The Conquest of Arid America*, emphasizes the importance of Roosevelt's western experience. One chapter of the book is entitled "Irrigation in the White House." Also, Smythe refers to Roosevelt as the "Irrigation President."

[27] Theodore Roosevelt, *Theodore Roosevelt, An Autobiography* (New York: Charles Scribner's Sons, 1927), p. 394.

[28] Webb, *op. cit.*, p. 362.

[29] E. Louise Peffer, *The Closing of the Public Domain* (Stanford, Calif.: Stanford University Press, 1951), p. 32.

The Reclamation Act has been the target of much criticism throughout its fifty years of existence. The Act began operation, however, with the confidence of the people that a sound national program for irrigation development had been enacted.

Irrigation of Indian Lands

The problem of irrigating Indian lands came to the fore early in the irrigation development of the West. In its capacity of guardian of the Indians, the federal government was concerned with the full utilization of the reservation lands. The first government venture was provided for in 1867 by an appropriation of funds for the construction of a canal for irrigating the Colorado River Reservation in Arizona.[30] For some time, the congressional approach was to consider each problem individually and to pass separate legislation for irrigation development on each reservation.

A more comprehensive plan was adopted as a part of the Act of April 30, 1908, making appropriations for the Indian Department for the next fiscal year. The Secretary of the Interior was authorized to make, as a part of projects undertaken under the Reclamation Act of 1902, such arrangements and agreements for the irrigation of all or any part of irrigable Indian lands as he thought would most benefit the Indians. Developments undertaken were not to create any lien or charge against the reserved lands.[31]

Awareness of the importance of Indian lands in irrigation development was further demonstrated in the Act of June 25, 1910, which provided for the withholding of lands valuable for power or reservoir sites. The Act also provided that no new irrigation project may be constructed on Indian lands without the specific authorization of Congress if the cost exceeds $35,000. The Leavitt Act of 1932 provides that construction costs for irrigation works be deferred so long as the Indian retains title to the land. Current assessments for operation and maintenance are chargeable to the Indian water user under terms of a 1914 statute.[32]

[30] President's Water Resources Policy Commission, Report of, Vol. III: *Water Resources Law* (Washington, D.C.: Government Printing Office, 1950), p. 246.

[31] *Federal Reclamation Laws Annotated, op. cit.*, p. 111.

[32] President's Water Resources Policy Commission, Report of, *op. cit.*, Vol. III, pp. 250–51.

The Warren Act

By the Act of February 21, 1911, the federal government was authorized to enter into contracts for the sale of excess water when the storage and carrying capacity of a project constructed under the Reclamation Act was greater than the requirements of the land to be irrigated within the project itself. The Act is popularly known as the Warren Act, being named for Senator Francis E. Warren of Wyoming.

The Secretary of the Interior was authorized to contract for the storage and carriage of water for irrigation systems operating under the Carey Act with individuals, corporations, associations, and irrigation districts organized for or engaged in furnishing or in distributing water for irrigation. First rights to water were to be preserved for lands and entrymen under the reclamation project. The party or organization with which the government contracted was to deliver water to individual water users at a rate not exceeding the charge paid to the United States plus a reasonable fee for the cost of carriage and delivery of such water through its works. Delivery of water was limited to an amount sufficient to irrigate 160 acres as in the case of lands regularly under federal reclamation projects. Moneys received from the sale of excess water were to be paid into the reclamation fund and to become available for further development under terms of the Reclamation Act.[33]

The Reclamation Extension Act

The objective of providing family farms on federal irrigation projects was further emphasized and strengthened by the Reclamation Extension Act of 1914. Section 13 of this Act reduced the size of individual holdings to a "farm unit" to be determined for each project by the United States Department of the Interior.[34] This means that homesteads on public lands on federal irrigation projects may be of any acreage determined to be sufficient for a farm unit up to a maximum of 160 acres.

Another provision of the Reclamation Extension Act was concerned with excess areas of privately owned lands under new proj-

[33] *Federal Reclamation Laws Annotated, op. cit.*, pp. 140–44.
[34] *Ibid.*, p. 173.

ects. Before any contract is let or work begun for the construction of any reclamation project, the Secretary of the Interior shall require individual landholders to dispose of all lands in excess of the area which he shall deem sufficient for the support of a family upon the land in question, upon such terms and at not to exceed such price as the Secretary of the Interior may designate. If any landowner refuses to comply, his land shall not be included within the project if adopted for construction.[35] The Reclamation Extension Act also contained important provisions for graduated repayment schedules. These will be discussed later in our consideration of the problems involved in financing irrigation development.

The Fact Finders' Commission

The foregoing summary of legislation passed in the interests of federal irrigation development indicates that a solution to the problems faced was yet to be found. The generally unsatisfactory situation led the Secretary of the Interior, on September 8, 1923, to appoint a commission to study the problems involved in federal irrigation development and to make recommendations as to changes needed. The commission was organized in October, 1923, and held hearings in Washington as well as in the West. The Fact Finders' Commission sent its report to the Secretary of the Interior under date of April 10, 1924. Eleven days later, the President transmitted the report to Congress and urged the legislators to undertake immediately the job of revising the Reclamation Act.[36]

The report of the Fact Finders' Commission contained sixty-six recommendations.[37] The most important proposals regarding existing projects were: (1) that Congress provide such temporary relief as might be justified; (2) that construction costs apportioned to land that cannot repay it be suspended and written off if the land cannot produce sufficient income; (3) that a classification of soils be made and a fair and equitable adjustment of construction charges be worked out to fix the charge per acre at a sum the land could reasonably bear; (4) that the repayment of construction charges be a percentage of the average annual farm returns rather than being a percentage of the total cost of construction; (5) that agricultural

[35] *Ibid.*

[36] Teele, *op. cit.*, p. 76.

[37] Senate Document 92, 68th Cong., 1st sess., 1924, *The Fact Finders' Report.*

advisors be assigned to the various projects to assist the settlers to improve their farm operations and increase their income; (6) that credit be available to the settlers for permanent improvements, equipment, and livestock.

It is significant that, for the first time, there was a recognition of the fact that some lands in federal irrigation projects would never be able to pay the full construction charges apportioned to them.

With regard to new irrigation developments and extensions of old projects, the Commission recommended: (1) that they be authorized only after "full information has been secured concerning the water supply, engineering features, soil, climate, transportation, markets, land prices, probable acre cost of development, and other factors upon which the success of the project must depend"; (2) that greater care be exercised in making estimates of probable construction costs and that, once announced, they be binding alike on the government and the settler; (3) that cost of drainage, land leveling, and distribution systems be made a part of construction costs; (4) that loans to settlers for development be a part of the federal irrigation program; (5) that settlers be selected on the basis of industry, experience, character, and the possession of a part of the capital needed in improving their farms; (6) that the lands be classified according to their productive capacity and that it be permissible to fix different construction costs on the various land classes under the same project; (7) that productivity be the basis for the annual repayments of construction costs and that the annual per acre repayment charge be 5 per cent of the average annual gross income per acre; (8) that agricultural advisors be employed; (9) that credit be available to settlers for financing permanent improvements, equipment, and livestock.[38]

These recommendations were contained in a bill submitted with the Fact Finders' Report. The bill failed of passage but some of the features of the program were contained in a rider to a deficiency bill enacted in December, 1924. Section 4 of the second Deficiency Bill, fiscal year 1924, known as The Fact Finders' Act, (1) made the approval of new projects contingent upon information as to water supply, engineering features, cost, land prices, feasibility, and adaptability for settlement and farm homes; (2) required of each appli-

[38] Teele, *op. cit.*, pp. 77–78; also John A. Widtsoe, *Success on Irrigation Projects* (New York: John Wiley & Sons, Inc., 1928).

cant such qualifications of industry, experience, character, and capital as the Secretary of the Interior deems necessary to assure success of the prospective settler; (3) provided that irrigable lands of new projects be classified and different construction charges be fixed against the different classes of land; (4) required issue of two public notices relating to construction charges with the second notice to fix the date when payments will begin; (5) provided that construction charges be based on productive power of the land with the annual charge being 5 per cent of the average gross annual acre income for the ten calendar years first preceding or for all years of record if fewer than ten years are available, annual payments continuing until the total construction charges are paid; and that, whenever two-thirds of the irrigable area of any project shall be covered by water right contracts between the water users and the United States, an irrigation district or water users' association must be formed to transact business with the government.[39]

From Public Lands to Private Lands

The Reclamation Act of 1902 was a logical and integral part of public land policy in the United States. The broad general policy was to transfer public lands to private ownership, i.e., into the hands of small farmers. By 1900, much of the residue of the public domain required irrigation if it was to be settled in small farm units.[40]

Although designed as a part of public land policy, the Reclamation Act was concerned with privately owned lands early in its existence. Every part of the West regarded itself as a potential area of activity for the new Reclamation Service. All land considered remotely susceptible of irrigation was withdrawn and made subject to homestead entry only. In some instances, reclamation withdrawals could not be made immediately for unavoidable reasons. Speculators were enabled to gain title to much land under other laws such as the Desert Land Act and the Timber and Stone Act.[41] Two-thirds of all the land on the older projects was in private ownership when they were authorized.[42]

[39] *Federal Reclamation Laws Annotated, op. cit.*, pp. 273–76.

[40] Brown, *op. cit.*, p. 127.

[41] Peffer, *op. cit.*, p. 42.

[42] Elwood Mead, "Present Policy of the United States Bureau of Reclamation Regarding Land Settlement," *Proceedings of the American Society of Civil Engineers*, March, 1926, pp. 411–15.

Present federal irrigation development is concerned primarily with lands in private ownership which are partially irrigated or farmed without irrigation.[43] The dominance of private lands in new public irrigation development gives rise to many of the problems considered in later chapters.

[43] Mont H. Saunderson, *Western Land and Water Use* (Norman, Okla.: University of Oklahoma Press, 1950), p. 7.

CHAPTER 4

Water Rights and Their Administration

Irrigation water is often referred to as the "lifeblood of the West." The importance of water in the economy of the western United States is emphasized by the competition for its control and use. The utter seriousness of people in the semiarid states with regard to their water supplies is illustrated by two Associated Press dispatches. Both incidents occurred when the United States Air Force was receiving much publicity for its rain-making experiments with dry ice pellets dropped from airplanes. In the first case, the manager of a 12,000-acre ranch in Nevada filed a water rights claim with the state engineer's office "to water in all the clouds passing over the ranch." [1] The second news story featured a telegram from the secretary of the Salt Lake City (Utah) Chamber of Commerce protesting attempts to cause artificial snow in the Sierra Nevada area west of Reno. The secretary threatened court action to halt "this illegal diversion" of precipitation and told Nevada to "cease and desist from milking the snow from Utah-destined clouds." [2]

Competition for water is not new. Hammurabi reigned for about fifty years in Babylon about 2050 B.C. during which time he developed an elaborate code of laws including some highly significant water laws. Rights to the use of water were ranked as follows: first, men and beasts; second, household use; third, irrigation; and fourth, navigation. Hammurabi also decreed penalties for wasting water which resulted in damage to a neighbor's crops or property. Paragraphs 53–56 from The Code of Hammurabi read as follows:

> If a man neglect to strengthen his dyke and do not strengthen it, and a break be made in his dyke and the water carry away the farm land, the man in whose dyke the break has been made shall restore the grain which he has damaged.
>
> If he be not able to restore the grain, they shall sell him and his

[1] *The Bozeman Daily Chronicle* (Montana), December 10, 1947.
[2] *The Great Falls Tribune* (Montana), January 3, 1948.

goods, and the farmers whose grain the water has carried away shall share [the results of the sale].

If a man open his canal for irrigation and neglect it and the water carry away an adjacent field, he shall measure out grain on the basis of the adjacent field.

If a man open up the water and the water carry away the improvements of an adjacent field he shall measure out 10 GUR of grain per GAN.[3]

Available Supplies of Water

A study of water rights should be prefaced with an understanding of the available supplies of water. Wiel states that, from the point of view of the law, occurrences of water may be grouped in two great classes. They are those *definite* in form and occurrence and those *indefinite* in form and occurrence. Running water (watercourses, surface or subterranean) and standing water (lakes and ponds) make up the definite class. Diffused surface water (rain water, swamps, the sea, etc.) and diffused underground water (percolating water) are included in the indefinite class. Wiel further states that the law is most concerned with definite bodies of running water, i.e., watercourses.[4] In the more than four decades since Wiel made the above statement, growing demand for water has caused lawyers to become increasingly concerned with lakes and ponds as sources of surface water and with all sources of ground water. With the coming of modern "rain making," this concern extends to the rights to atmospheric moisture.

The problem of legal rights to the use of water is a result of scarcity of water relative to demand. Man is concerned, therefore, with the physical phenomena associated with the occurrence of water whether it be surface water or ground water. As the pressure of demand on the available supplies of water has increased, man has attached greater importance to the sources of water and their permanence.

The various sources of water will yield a perennial supply if they are replenished by precipitation seasonally, annually, or at less frequent intervals. The process by which water reaches the various

[3] Charles E. Cone, "Ancient Water Codes," *Reclamation Era*, XXXIII, No. 9 (September, 1947).

[4] Samuel C. Wiel, *Water Rights in the Western States* (3d ed.; San Francisco: Bancroft-Whitney Co., 1911), I, p. 1.

sources mentioned above comprises a distinct field of knowledge. The science of hydrology is concerned with the behavior of water as it occurs in the atmosphere, on the surface of the earth, and underground. The sequence of phenomena—precipitation, infiltration, runoff, evaporation, condensation, and precipitation again—is called the hydrologic cycle.[5] Thomas describes the hydrologic cycle as follows:

> Precipitation and evapotranspiration are processes in the natural circulation of water which is going on at all times. The term "hydrologic cycle" has been applied to the march of events marking the progress of a particle of water from the atmosphere to the land masses and oceans and its return to the atmosphere. The two basic forces that keep the cycle going are solar energy and the gravitational pull of the earth. Gravity is the controlling force not only in the precipitation but in the downward movement of water thereafter in streams or below the land surface. Underground, molecular attraction becomes an important force that resists the movement of water by gravity. Where the openings or pores in rocks are sufficiently minute, the force of molecular attraction is powerful enough to prevent any movement of water through them.
>
> The effectiveness of the solar energy in pulling water back to the atmosphere varies from time to time and from place to place, but this force is operating at all times upon all water within reach. Water is evaporated from oceans, lakes, reservoirs, streams, canals, swamps, vegetation, and moist earth; it may evaporate as soon as it hits the ground—or even before—in hot deserts, and it may return to the atmosphere from snowbanks or ice fields at temperatures far below freezing; it is transpired by all vegetation, and thus the "reach" of this solar force extends below the land surface as far as plants can send their roots for water, or in the absence of vegetation, as far down as air can circulate.[6]

A diagrammatic picture of the hydrologic cycle is contained in Figure 1. The diagram illustrates the validity of this statement: "The real source of water is the great lakes and the oceans, which cover approximately three-fourths of the surface of the earth. Evaporation is constantly taking place from these great reservoirs."[7]

[5] Thorndike Saville, "Basic Principles of Water Behavior," in *Headwaters Control and Use*, Upstream Engineering Conference, Washington, D.C., September 22–23, 1936.

[6] By permission from *The Conservation of Ground Water*, by Harold E. Thomas, pp. 15–16. Copyright, 1951, McGraw-Hill Book Co., Inc., New York.

[7] C. R. Orton, "The Conservation of Water," *Journal of Soil and Water Conservation*, III, No. 4 (October, 1948), 176–79.

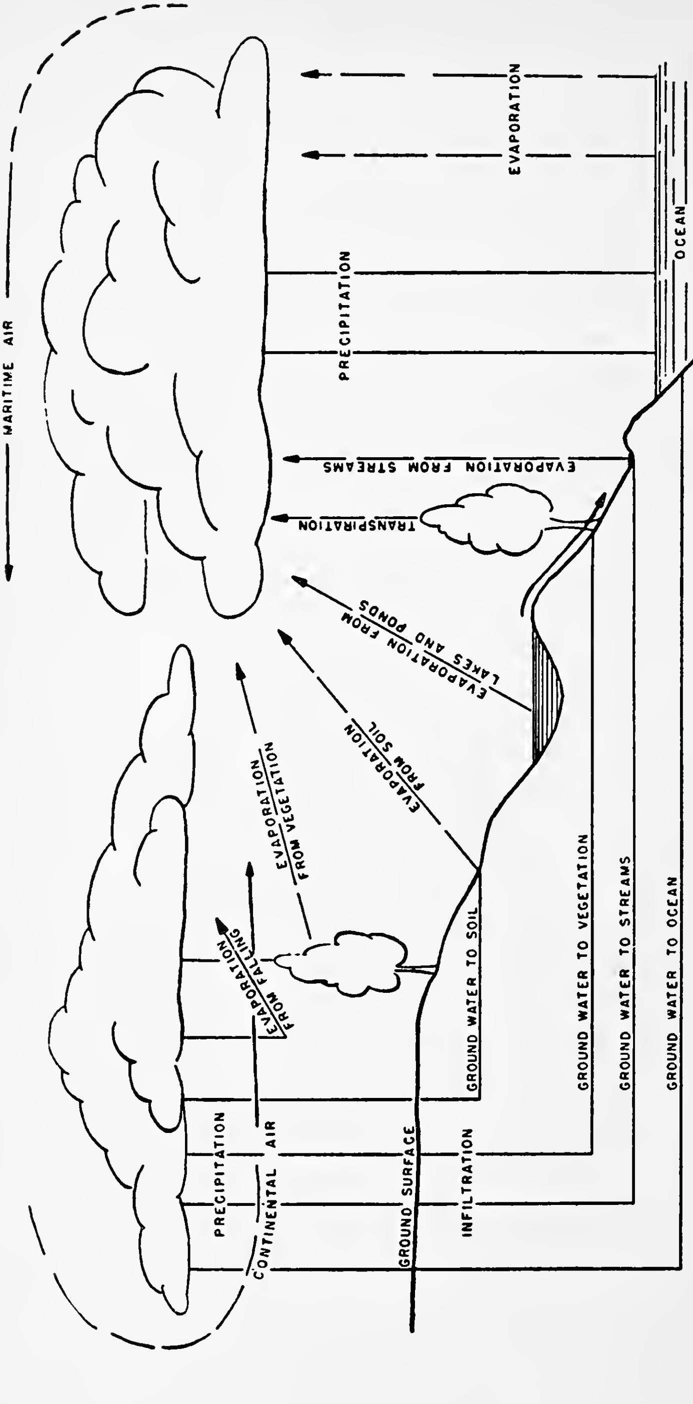

FIGURE 1. The Hydrologic Cycle. (Adapted from *Climate and Man, Yearbook of the U.S. Department of Agriculture,* Washington, D.C.: Government Printing Office, 1941.)

The supply of water is limited in much of the West and is becoming increasingly scarce relative to demand in many humid areas. It is not possible to allow freedom of use without restrictions. The established market structure does not provide an adequate means of apportioning and regulating control and use of water on an equitable basis in many areas—particularly in the arid and semiarid West. To use the terminology of John R. Commons, water rights are a result of *rationing* transactions by units of government rather than *bargaining* transactions in the market place.[8] Once water rights have been granted by government, they may become a part of bargaining transactions but usually as a part of market operations in connection with land. Many times water is the source of most or all of the economic value of the land. The nature and extent of the original rights to water, however, remain associated largely with rationing transactions. In laying down the working rules within which the rationing process is carried on, the political units of government have built up a complex body of law concerned with water rights.

The Doctrine of Riparian Rights

The United States drew much of its legal structure from the English common law. The humid climate of England created a situation where water was in demand mainly to fill domestic needs and livestock requirements and to furnish direct power for milling. None of these uses reduces the flow in a stream materially. It was natural for the custom to develop of giving the advantage in water rights to those whose land bordered on the stream.[9] It is interesting to note, however, that as late as 1831 the English law granted the right of use of flowing water to the first who appropriated it. The riparian doctrine was announced in 1833 but the term "riparian" was used for the first time in English court decisions in 1849. The doctrine of riparian rights to water, as adopted by the English, had its foundation in the French Civil Code.[10] Two American jurists,

[8] John R. Commons, *The Economics of Collective Action* (New York: The Macmillan Co., 1950), p. 43. This concept was also prominent in Professor Commons' earlier writings.

[9] S. T. Harding, *Water Rights for Irrigation* (Stanford, Calif.: Stanford University Press, 1936), p. 6.

[10] National Resources Planning Board, *State Water Law in the Development of the West* (Washington, D.C.: Government Printing Office, 1943), p. 5.

Story and Kent, had expounded the civil-law doctrine of riparian rights prior to 1833 with emphasis upon the French sources. When the English first used the term "riparian" in 1849, reliance was placed mainly upon Kent and Story. In reality, then, the English jurists who are commonly credited with the formulation of the riparian doctrine based their concept on the work of two Americans.[11]

The doctrine of riparian rights gives to the owners of land bordering on a stream or lake certain rights not enjoyed by nonriparian owners.[12] The common-law doctrine of riparian rights entitles each owner of land bordering on a stream to have the waters thereof flow in the natural channel, unpolluted in quality and undiminished in quantity. Strictly interpreted, the doctrine would forbid any use of the waters of the stream. It was modified in England to recognize two uses—ordinary or natural, including use for domestic and livestock purposes, and extraordinary or artificial, including use for irrigation and mechanical purposes. The upper riparian owner may take the entire stream for "ordinary" uses if necessary, but for "extraordinary" uses he is limited to an amount of water which will not interfere with a like use by other riparian owners.[13] The right of a riparian owner to the continued natural flow of the stream is enforceable by judicial process.[14] The use of water is restricted to riparian landowners and the right is an automatic one which is not created by use nor lost or forfeited through disuse.[15]

The riparian water right is not proprietary as in the case of land but is usufructuary—riparian owners enjoy the privilege of using the water. Kinney quotes Blackstone as follows:

> For water is a movable, wandering thing, and must of necessity continue common by the law of nature; so that I can only have a temporary, transient, usufructuary property therein; wherefore, if a body of water runs out of my pond into another man's, I have no

[11] Wells A. Hutchins, *Selected Problems in the Law of Water Rights in the West*, U.S. Department of Agriculture Miscellaneous Publication 418 (Washington, D.C.: Government Printing Office, 1942), p. 39.

[12] Richard T. Ely and George S. Wehrwein, *Land Economics* (New York: The Macmillan Co., 1940), p. 367.

[13] A. E. Chandler, *Elements of Western Water Law* (San Francisco: Technical Publishing Co., 1913), p. 11.

[14] President's Water Resources Policy Commission, Report of, Vol. III: *Water Resources Law* (Washington, D.C.: Government Printing Office, 1950), p. 156.

[15] Chandler, *op. cit.*, p. 27.

> right to reclaim it. But the land which that water covers is permanent, fixed and immovable, and therefore, in this, I may have a certain substantial property of which the law will take notice and not of the other.[16]

The same basic tenet applies to the doctrine of appropriation in the western states. The National Resources Planning Board wrote:

> The water right which attaches to a watercourse is a right to the use of the flow, not ownership of the water itself. This is true under both the riparian doctrine and the appropriation doctrine. This right to use is a property right, entitled to protection to the same extent as other forms of property and is regarded as real property. After the water has been diverted from the stream flow and reduced to possession, the water itself becomes the personal property of the riparian owner or the appropriator, except in California.[17]

The states comprising the eastern portion of the United States found little reason to modify that portion of English common law having to do with water rights. When the law was applied to the arid regions, however, it was found to be inadequate as it pertained to irrigation.[18] The courts of some of the western states have held that adoption of the common law of England included an adoption of the riparian doctrine of rights to water in watercourses.[19] The development of water laws suited to the arid and semiarid lands has been an evolutionary process wherein eight states have completely abrogated the common law and nine states have retained the common law in modified form. The states which have retained the riparian doctrine in varying degree are those forming the perimeter of the arid West—California, Oregon, and Washington on the west and North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas on the east. The eight states which abandoned the riparian doctrine form the heartland of the arid West—Montana, Idaho, Wyoming, Nevada, Utah, Colorado, Arizona, and New Mexico.[20]

[16] Clesson S. Kinney, *A Treatise on the Law of Irrigation* (Washington, D.C.: W. H. Lowdermilk & Co., 1894), p. 85.

[17] National Resources Planning Board, *op. cit.*, p. 5.

[18] Walter Prescott Webb, *The Great Plains* (Boston: Ginn & Co., 1931), p. 432.

[19] National Resources Planning Board, *op. cit.*, p. 5.

[20] Webb, *op. cit.*, p. 438.

The Doctrine of Appropriation

Present laws and policies regarding rights to the use of water in the western states are largely an outgrowth of customs established in the early mining camps. The great gold rush of 1849 brought many legal controversies regarding the ditches and water rights connected with mining claims. The first appropriators of water were miners who began the custom of initiating water rights by posting notices similar to those used for mineral claims. Many of the points where water was diverted from streams were isolated spots, and it is doubtful if anyone excepting the person posting the notice ever saw it. Many miners recorded the water claims in county records long before they were required to do so by legislation.[21]

Webb points out that the arid-region doctrine of prior appropriation, while indigenous to the West, had its rudiments in Roman civil law and in the Spanish and Mexican law as it was applied in the Southwest before the Treaty of Guadalupe-Hidalgo. It was provided in the Treaty (by which the United States acquired all the Southwest except the portion acquired later by the Gadsden Purchase) "that the United States should recognize and respect the vested rights and interest of the people who had occupied the country under Mexican and Spanish rule. Land grants (which included, of course, grants of water rights) were to be protected. Thus it came about that the state and federal governments recognized the customs and laws in force in Mexico." [22]

The principles of the Mexican laws as applied in the Southwest are listed by Webb as follows:

> 1. The Mexican government owned the rivers and streams, and held that the *corpus* of water belonged to no one; but the government could *confer* the exclusive use of a portion of the water on an individual or a corporation.
>
> 2. The Mexican government could confer this right on owners of lands either riparian or nonriparian.
>
> 3. The Mexican government had the right to grant the exclusive rights to water of nonnavigable streams under stipulated conditions as to use. If the user complied with the conditions, he had a vested right in the water as long as he continued to use it. But there was no provision in the Mexican law for the acquisition of exclusive rights by

[21] Chandler, *op. cit.*, pp. 1–6.

[22] Webb, *op. cit.*, pp. 440–41.

prior appropriation. This feature was to be added by the Western states, and distinguishes the arid-region doctrine clearly from the Mexican system.[23]

California was one of the states which adopted the doctrine of riparian rights. It became the battleground where many of the conflicts between the riparian and appropriation systems were most violent. Nadeau refers to the situation as "the last technical clash between the merging civilizations of Spanish California and the American West." [24] The gold miners of California took the lead in opposing the riparian doctrine as not being adapted to the region, but, at the same time, they urged that application of the appropriation doctrine be limited to the mining industry and not be extended to agriculture for purposes of irrigation.[25]

It is only when the demand exceeds the supply that the relative rights to water become important. Unlike the Spaniards and Indians who created the great irrigation civilizations in the Southwest and south of the Rio Grande, those who settled the Atlantic seaboard and moved across the continent had never found water to be a problem.[26] Kinney quotes Mr. Justice Barnes, of the Supreme Court of Arizona, as follows in a decision in 1888: "The right to appropriate and use water for irrigation has been recognized longer than history, and since earlier than tradition. Evidences of it are to be found all over Arizona and New Mexico in the ancient canals of a prehistoric people who once composed a dense and highly civilized population." [27] It is probable that these ancient peoples had developed institutional arrangements which fitted the arid region, but they had not been handicapped by a training adapted to a culture which had matured under vastly different conditions.

The Mormon pioneers who crossed the Great Plains to the valley of the Great Salt Lake were the first agriculturists from the humid eastern United States to face the problem of developing a system of water laws for the arid region. Brigham Young outlined the nature of the society to be developed there when he spoke to his

[23] *Ibid.*, p. 441.
[24] Remi A. Nadeau, *The Water Seekers* (New York: Doubleday & Co., Inc., 1950), p. 10.
[25] Hutchins, *op. cit.*, p. 69.
[26] Jay Franklin, *Remaking America* (Boston: Houghton Mifflin Co., 1942), p. 91.
[27] Kinney, *op. cit.*, p. 22.

followers at the end of their migration: "No man can ever buy land here, for no one has any land to sell. But every man shall have his land measured out to him, which he must cultivate in order to keep it. Besides, there shall be no private ownership of the streams that come out of the canyons, nor the timber that grows on the hills. These belong to the people: all the people." [28]

The Utah settlers were confronted with the problem of distributing a meager supply of water for irrigation purposes. The doctrine of riparian rights was not suited to the development of irrigation farming and it was promptly repudiated. The water law developed in Utah and those which evolved in other isolated communities of the West had one thing in common which was foreign to the riparian doctrine. Beneficial use was declared to be the basis, the measure, and the limit of a water right. The leader of the Mormon pioneers, Brigham Young, said, "No man has a right to waste one drop of water that another man can turn into bread." The principle was laid down that water belongs to the people and no man can gain title to more than he can use in a beneficial manner.[29]

The question of what constitutes beneficial use of water has been only very gradually determined. In the case of the Utah experimentation, the task of reaching answers acceptable to the people was eased by the fact that they were all of the same religious faith and that they respected and obeyed the laws of the Church "courts." [30] The only other group participating in the expansion of the United States to show such a degree of cooperation was the Puritans of Massachusetts. Both groups were intensely religious.[31]

Western water law, then, as we know it today is a result of trial and error, gradual experimentation, and the obvious need for new rules of the game if water was to be used effectively. For irrigation purposes, as well as other uses, land contiguous to the stream was not the place where water was to be utilized. In the case of irrigation, benchland some distance above and removed from the stream channel was often the more fertile and the better adapted to agriculture.

[28] By permission from *Westward Expansion*, by Ray Allen Billington, p. 540. Copyright, 1949, The Macmillan Co., New York.

[29] William R. Palmer, "Utah's Water Courts," *Reclamation Era*, XXXIII, No. 11 (November, 1947).

[30] *Ibid.*

[31] Billington, *op. cit.*, p. 541.

The doctrine of appropriation as it finally evolved provides that anyone who will put water to a beneficial use may take or appropriate it; and the right to continue to take it exists so long as the use continues, provided such use does not conflict with use by someone who made an earlier appropriation from the same source. "First in time, first in right" is the classical statement of the appropriation doctrine.[32]

The important features of the appropriation doctrine can be summarized as follows:

1. It gives an exclusive right to the first appropriator; and, in accordance with the doctrine of priority, the rights of later appropriators are conditional upon the prior rights of those who have preceded.
2. It makes all rights conditional upon beneficial use—as the doctrine of priority was adopted for the protection of the first settlers in time of scarcity, so the doctrine of beneficial use became a protection to later appropriators against wasteful use by those with earlier rights.
3. It permits water to be used on nonriparian lands as well as on riparian lands.
4. It permits diversion of water regardless of the diminution of the stream.
5. Continuation of the right depends upon beneficial use. The right may be lost by nonuse.

The Doctrine of Relation Back

The doctrine of prior appropriation, in itself, gives rise to questions regarding the date from which priority is calculated. The problem is covered by what is known as "the doctrine of relation back." This doctrine is found, in some form or other, in the statutes or decisions of every western state. The doctrine of relation back says that as between two persons digging ditches at the same time, and prosecuting work thereon with reasonable diligence to completion, the one who first began work had the prior right, even though the other had completed his first.[33] Before the doctrine of relation back was applied, the essential elements of an appropriation were a

[32] R. P. Teele, *Irrigation in the United States* (New York: Appleton-Century-Crofts, Inc., 1915), p. 85.

[33] James Heckathorn, "The Doctrine of Relation Back in Montana Water Law," *Montana Law Review*, XII (Spring, 1951), 87–97.

completed ditch, an actual diversion of water, and an application of water to a beneficial use. To base the priority of the appropriation right upon the completion of work or the actual beneficial use of water could put a premium on hasty and shoddy construction. Insistence on the actual application of water to a beneficial use as a condition precedent to the creation of a right is a handicap to certain types of development. To deny the right of a public service corporation to make an appropriation independently of its present or future customers would be to discourage the formation of such corporations and greatly retard the reclamation of arid lands in localities where the magnitude of the undertaking is too great for individual enterprise.[34]

Compliance with the law is a condition precedent to application of the doctrine of relation back. In Montana, for example, if the appropriator fails to comply with the requirement that he post a notice of appropriation, file the notice with the county clerk within twenty days, begin work within forty days and complete it with reasonable diligence, he forfeits all rights to relation back and his right will date from the date of diversion and beneficial use.

Variations in Western Water Law

The appropriation doctrine has been adopted in all seventeen of the arid and semiarid states. We noted earlier that eight states adopted the appropriation doctrine as the only basis of water rights and that nine states adopted a hybrid appropriation-riparian doctrine. The exclusive appropriation system is often called the "Colorado doctrine" and the twofold system is referred to as the "California doctrine." [35]

Teele classified the appropriation system and listed three doctrines of western water rights as follows: [36]

1. The common law of riparian rights as it has been modified by judicial decisions and state legislation. It is commonly called the *California* doctrine because it was first stated by the courts of that state.
2. The civil-law doctrine that the waters of streams belong to the state. It is commonly called the *Wyoming* doctrine because it

[34] *Ibid.*
[35] National Resources Planning Board, *op. cit.*, p. 8.
[36] Teele, *op. cit.*, pp. 85–87.

was included in the constitution of Wyoming when it was admitted to the Union in 1890.

3. The doctrine of appropriation that the waters of the streams belong to the public. It is commonly called the *Colorado* doctrine because it was included in the constitution of Colorado when it was admitted to the Union in 1876.

Webb suggests that more efficient use of the available resources would have been made in the development of the West if the federal government had retained control of the water as it did of the land. Failure to enact a uniform federal water law was a result of failure to recognize the importance of the land-water relationship in the arid and semiarid West. The administration and control of water rights passed by default to the states.[37]

State Regulation of Water Rights

The administration of water rights varies from state to state. The principal difference between the Colorado and Wyoming systems lies in the laws relating to acquisition and defining of water rights. In Wyoming, right to the use of water is acquired by a grant from the state. The rights are defined and established as acquired.[38] The granting of water rights by the state has the effect of bringing all the information together at a central point. In Colorado, water rights are acquired by appropriation, and maps and other information must be filed with the state engineer. Many states required no more formality than the posting of a notice at the point of diversion and the filing of copies of the notice with the county recorder or county clerk.[39] Under this system, there is little if any bringing together of information on a state basis. There is often much confusion because of identical stream names in different counties or even in the same county. Filing of an appropriation notice with the proper official is no assurance that an adequate water supply is available to fill all the claims. Many streams are appropriated many times over their maximum flow even in wet years.

The only western state in which there is now no provision for filing a notice of appropriation with a state administrative organiza-

[37] Webb, *op. cit.*, p. 450.
[38] Teele, *op. cit.*, pp. 87–88.
[39] *Ibid.*, p. 89.

tion is Montana.[40] As a result of the use of the decentralized county by county system of recording appropriations, Montana has found it necessary to embark on an expensive and lengthy program of assembling all the water rights data in the state. The survey is being conducted by the state engineer and the Montana Water Conservation Board. There is a certain amount of urgency in the task for two reasons:

1. Much of the information required is not in recorded form but is in the minds of pioneer residents of Montana. If the information is to be secured at all it must be obtained before these aged people pass on.

2. The expanded activity in federally sponsored irrigation development, particularly in the case of large projects which overlap existing irrigation enterprises, brings with it a need for exact information regarding water rights on the streams of Montana.

Defining of Water Rights

The defining of water rights is left to the courts in all seventeen western states with the exception of Wyoming and Nebraska where water rights are defined by administrative boards as acquired. The process of definition by the courts usually takes place as a result of a dispute between two or more claimants to water from a particular stream. The court action is known as the *adjudication* of the water rights. Most states require that all parties claiming rights to water from the same source shall be made parties to the action so that all rights may be determined in a single adjudication action. When rights are adjudicated by the courts, certificates are issued to the holders of rights stating the volumes of water to which they are entitled, the dates of their rights, and the number of rights in the order of their priority. They do not show that there is water in the streams to supply all these rights.[41]

Any claimant to water may bring action to have the rights of a stream adjudicated. Often the state is interested in having the rights to water determined on streams where no private action has been taken. In some states the attorney-general may bring suit to determine water rights; in others it is a responsibility of the state engi-

[40] National Resources Planning Board, *op. cit.*, p. 11.
[41] Teele, *op. cit.*, pp. 172–76.

neer. In Wyoming and Nebraska, where the administrative boards exercise a quasi-judicial function, the determinations made by the boards are final unless appealed to the courts. In no case are individuals precluded from recourse to the courts for protection of their water rights.[42]

Loss of Water Rights

Water rights acquired under the doctrine of appropriation are subject to loss through voluntary abandonment, statutory forfeiture, adverse use by another, and estoppel. Appropriation rights can be acquired only through beneficial use of water and can be maintained only through continued use. The four ways in which appropriative rights are lost may be defined as follows:[43]

1. Abandonment consists of voluntary relinquishment and nonuse of the right, coupled with an intention to forsake or desert the right and not to renew the use of the water. Hence it is a matter of intent coupled with corresponding conduct.

2. Statutory forfeiture consists of loss of rights through failure to use water during a number of successive years stated in the statutes of the particular state. Forfeiture is based upon a time element—nonuse for a given number of years.

3. Adverse use involves use on the part of another of the water for the prescriptive period defined in the statute of limitations of actions to recover real property. The adverse use must be open and notorious for the statutory period and under a claim of right, and must amount to such an invasion of the right as would furnish a cause of action in favor of the owner.

4. Estoppel involves loss of rights by an appropriator who, by inequitable conduct or by acts or declarations, leads others to make use of his rights in reliance thereon. The person seeking to assert an estoppel must have acted in reliance upon the acts of the appropriator to his detriment.

The abandonment or forfeiture of rights adds to the unappropriated public water and the benefits therefrom are not intended to accrue to a particular person.[44]

[42] Hutchins, *op. cit.*, p. 76.
[43] National Resources Planning Board, *op. cit.*, pp. 17–19.
[44] Chandler, *op. cit.*, p. 47.

Transfer of Water Rights

Appropriative water rights are not tied to the land in all instances. A water right may pass with the land but not necessarily so. In most states, it can be conveyed apart from the land on which it is used by the holder of the right provided that the rights of others are not injured by so doing. In other words, the use of water may be transferred from one owner to another where the land does not make the same change of ownership.

The right to change the point of diversion is authorized by statute in all western states except Arizona and Wyoming. The right is subject to the restriction that no injury be thereby inflicted upon others.

A majority of the western states authorize changes in place of use by a holder of a right. Again, there is the limitation that such action have no adverse effect upon the rights of others.

The appropriation doctrine permits the taking of water from one watershed for use in another watershed. However, some of the states have statutory restrictions upon such action. Diversion out of a watershed is subject to the rule that prior appropriators must not be injured.[45]

Colorado, Idaho, Montana, and Wyoming authorize the exchange of stored water for direct flow in certain circumstances, and New Mexico authorizes exchanges without limitation to stored water. This makes possible the use of water by upstream appropriators with late rights who can furnish a substitute supply to downstream appropriators with prior rights.[46]

Duty of Water

The problem of defining beneficial use of water has been mentioned. Questions regarding how much water a given crop requires and how often it should be applied are a part of the problem of determining when use of water becomes wasteful. Out of this problem has grown the phrase "duty of water." The duty of water repre-

[45] National Resources Planning Board, *op. cit.*, pp. 14–16.
[46] *Ibid.*, p. 47.

sents the quantity of water used for the production of crops. It is usually expressed as the amount of water in acre-feet applied to the land during the growing season.[47] In some cases the duty of water is expressed as the number of pounds of water required to produce one pound of dry matter of the crop. The duty is said to be high when a given quantity of water serves a comparatively large area of land, and low when it is made to serve only a comparatively small area; i.e., the duty is the work the water is made to do.[48] The quantity of water diverted at the intake of the irrigation system establishes the gross duty of water. The net duty of water is based on the amount actually delivered to the farm operator and used on his land.

Rights to Return Flow

All of the water appropriated may not be used by the appropriator. A part of it may escape from the distribution system, or control of it may be abandoned. Such escaped or abandoned water which reaches a natural water course is generally designated as "return flow." Title to return-flow water is acquired on the same basis as title to the original water in the natural channel. Under the appropriation doctrine, it is subject to appropriation in accordance with the laws of the state concerned.

The return flow is of sufficient volume and dependability in some areas to be of considerable significance. The burden of high construction costs can be reduced by including the maximum area which the available water can serve and thus spread costs over a greater acreage. Of course, irrigation projects should be designed to minimize return flow. In many cases, projects are so designed as to recover their own return flow and use it on additional lands within the project. In some instances, the project may benefit from the return flow by selling it for use on lands outside of the project itself.[49]

[47] John A. Widtsoe, *Success on Irrigation Projects* (New York: John Wiley & Sons, Inc., 1928), pp. 61–62.

[48] Don H. Bank, *Duty of Water Investigations*, Report of Idaho State Engineer, cooperative study of the Idaho State Board of Land Commissioners and the U.S. Department of Agriculture, Office of Experiment Stations (undated).

[49] Harding, *op. cit.*, pp. 25–27.

Rights to Ground Water

In cases where a surface water supply is not available or has been exhausted, man's attention is turned to possible underground sources. In many areas, surface water supplies have been largely developed—in most cases overdeveloped.[50] In such areas, undeveloped ground water is the only source of new water supplies.

Improvements in pumping equipment and the availability of satisfactory power, especially hydroelectric energy, have extended the areas where it is physically and economically possible to use ground water for irrigation.[51] These factors have, in turn, resulted in a heavy demand on the ground water supplies. In many areas, the supply has been, or soon will be, exhausted. One geologist has referred to the situation as "spreading like a creeping paralysis." The use of ground waters is largely unregulated inasmuch as only eight of the forty-eight states have laws governing their use.[52]

Ground water rights are less well defined in most cases than are rights to surface waters. Much of the delay in developing definite ground water laws has been due to a lack of knowledge regarding their occurrence and movement. The simple formula was devised that water in the ground is part of the soil and is owned by the landowner unless proved to be flowing in a definite underground stream. The courts have generally recognized two classes of ground water, (1) underground streams, and (2) percolating waters. Definite underground streams, in the opinion of the courts, are subject to the rules that apply to the surface streams in the same state. In other words, the riparian doctrine applies to ground waters in definite underground channels in those states where it applies to surface waters, and the appropriation doctrine is the law governing underground streams in the states under the appropriation doctrine.[53]

Three primary doctrines apply to rights in the use of percolating waters and the basis of definition varies from state to state.[54] They

[50] Garald G. Parker, "Ground Water Situation of the United States," *Soil Conservation*, XV, No. 3 (October, 1949), 53–58.

[51] J. A. Bird, *Western Ground Waters and Food Production*, U.S. Department of Agriculture Miscellaneous Publication 504 (Washington, D.C.: Government Printing Office, December, 1942), pp. 6–8.

[52] Lester Velie, "Are We Short of Water?" *Collier's*, May 5, 1948.

[53] Bird, *op. cit.*, p. 17.

[54] *Ibid.*, p. 18.

are (1) *absolute ownership*—the landowner is given unlimited right to recover ground water from under his land without restriction as to amount, manner of use, or place of use; (2) *reasonable use*—this doctrine gives ownership of percolating waters to the owner of the overlying land but requires that such water be reasonably used with regard to similar rights of other owners drawing from the same source; and (3) *the appropriation doctrine*—percolating ground waters are owned by the public but are subject to appropriation by individuals for beneficial use on a "first come, first served" basis. The waters need not be used on lands which overlie the ground water supply.

There is widespread agreement that more regulation of the use of ground water is desirable. The New Mexico ground water code is generally cited as the outstanding statute dealing with ground water now in existence. In New Mexico, the waters of underground streams, channels, and artesian basins are declared to belong to the public. As such, they are subject to prior appropriation for beneficial use. Permits must be obtained from the state engineer before drilling for artesian waters.[55]

Adequate legislation in the field of ground water law, while of extreme importance, will not provide a complete solution to the problem in all areas. In many instances, the situation requires a more comprehensive approach. Parker writes:

> The problem is not alone that of the hydrologist who determines the balance between input and outgo, and thus derives the "safe yield." It is also a problem for economists, businessmen, statesmen and philosophers, who must decide how long the stored water should be made to last and the conditions of its withdrawal. Hitherto, most legal concepts have been based on the assumption that withdrawal of ground water must be held within the limits of perennial yield . . ." [56]

Doctrine of Correlative Rights

In connection with the allocation of a limited supply of ground water among agricultural users, the doctrine of *correlative rights* has developed in California. It has been defined as follows:

[55] J. Russell Whitaker and Edward A. Ackerman, *American Resources—Their Management and Conservation* (New York: Harcourt, Brace & Co., Inc., 1951), p. 163.

[56] Parker, *op. cit.*

> According to this doctrine, each landowner is entitled in time of shortage of water to a reasonable proportion of the common supply of water that underlies land belonging to a group of owners. Fair as this law is from one point of view, it does not safeguard the man who came first, and who may not be able to get sufficient water for his farm because he must share it with more recent arrivals.[57]

It will be recalled that the California doctrine of water rights is a modified form of the riparian doctrine. The doctrine of correlative rights created no serious problem when applied to a situation where the riparian system of rights governed but came into immediate conflict with the doctrine of priority when applied to appropriated water. In California, certain judicial decisions stated that the common-law fundamentals applicable to appropriated waters were also applicable to riparian waters; the implication was that all water users should submit to the same degree of inconvenience and hardship in the use of a limited supply of water. These court decisions were based on considerations of moral fairness, the public interest, and the prevention of monopoly control of water.[58] Interest in this line of judicial reasoning has increased with population growth and heavier demands for water in the western states, but the doctrine of correlative rights has remained a minority viewpoint in western water law. Scattered decisions in western states other than California have stated the doctrine of correlative rights, but the doctrine of priority remains firmly rooted as the basis of western water law with beneficial use as the condition insuring an equitable distribution of resources to all users.

Rights to Atmospheric Moisture

Rain makers have been present in civilizations and cultures for centuries. They have been a part of the American scene for many years. Generally, they have been greeted with considerable skepticism if not outright ridicule. The most celebrated practitioner of this unique profession was George M. Hatfield. He contracted with cities and farmers for more than twenty years (1903 to the mid-twenties) to produce rain. Nadeau comments, "Whether he was a highly fortunate quack or a practical scientist ahead of his time was never quite determined by Southern Californians . . ." [59]

[57] Whitaker and Ackerman, *op. cit.*, p. 163.
[58] See Wiel, *op. cit.*, pp. 329–40.
[59] Nadeau, *op. cit.*, p. 13.

In more recent years, rain making has become big business. The work is now referred to as "rain increasing" programs. That the scale of operations is very large is indicated by the fact that 350,000,000 acres of cropland and range land in the western states were covered by contracts with the modern rain makers in 1951. There is as much disagreement regarding their success as prevailed during the time of Hatfield. But the fact remains that the operators of these lands gambled more than $3,000,000 for their services.[60]

What it all means in terms of rights to water and the administration of water resources is only now beginning to emerge. There are widespread demands for federal legislation to control the activities of the rain makers. It is likely, too, that the legislatures of many western states will also be framing legislation. The urgency of the situation is further emphasized by a number of large suits for damages brought by one group of producers who have suffered loss through excessive moisture against neighboring producers of another commodity who have been contracting with the rain makers. If the modern rain makers prove to be as successful as they and their enthusiastic supporters claim, their activities can have significant effects on runoff and, indirectly, on the established rights to surface waters. The immediate future should do much to clarify the situation.

Interstate Water Compacts

The boundaries of the western states are not based on drainage basins and are usually straight lines cutting across valleys and divides. Many of the streams, both large and small, are interstate in character. The courts of any one state do not have jurisdiction over the use of water outside the boundaries of that state. The intense competition for legal control and use of water so characteristic of the western states has, of course, resulted in numerous interstate disputes.

The most commonly used means of settling differences between or among states with regard to interstate streams is the *interstate water compact.* The federal government has an interest in interstate controversies as well as the states involved. The control of

[60] Paul Friggens, "Did Rainmakers Change the Weather?" *Farm Journal,* September, 1951, pp. 34–35, 149–50.

navigation is a federal function as a result of the provision in the Constitution giving the federal government control of interstate commerce. Navigation rights are superior to all other water rights on navigable streams. If a stream is classed as navigable, therefore, the federal government is the claimant of first importance in the settling of any dispute. The definition of navigable waters does not depend on present use or physical suitability. A river which was used a hundred years ago by boats of light draught remains "navigable" at law, even though present conditions prevent its use.[61]

The federal government is a participant in interstate compacts, however, whether or not an interstate stream is navigable. Section 10 (3) of Article I of the Federal Constitution provides that: "No state shall, without the consent of Congress, . . . enter into any agreement or compact with another state . . ." This negatively worded compact clause has been construed to mean that the Constitution authorizes a state to enter into any agreement or compact with another state with the consent of Congress.[62]

Two different procedures have been recognized in the negotiation of interstate water compacts. Under one, an act is passed by Congress giving its consent to the making of a compact. The compact is negotiated by commissioners appointed by the governors of the participating states. The negotiated pact is then submitted to the legislatures of the signatory states for ratification and finally to Congress for approval. Under the second procedure, the compact is negotiated and ratified by the states without previous congressional consent. In either case, the required constitutional consent is not effectuated until the full text of the compact is before Congress and approved by that body. In most cases, it is considered advisable to obtain previous consent from Congress to make a water compact before attempting to negotiate its terms.[63]

The question of federal government interest in the apportionment and control of the use of waters of interstate streams for irrigation is of foremost importance. The present day large-scale

[61] Lester V. Plum, "The Definition of Navigable Waters and the Doctrine of Minor Interest," *Journal of Land and Public Utility Economics,* XIII, No. 4 (November, 1937), 398–405.

[62] Garland C. Routt, "Interstate Compacts and Administrative Cooperation," *The Annals of the American Academy of Political and Social Science,* CCVII (January, 1940), 93–102.

[63] See *Preservation of Integrity of State Water Laws,* Report and Recommendations of a Committee of the National Reclamation Association, October, 1943.

expansion of irrigation development with a maximum of federal participation results in the federal government becoming an ever more important party to the many problems surrounding equitable use of water in the arid and semiarid West.[64] The irrigation states of the West secured passage of federal legislation to guarantee the superiority of irrigation rights over navigation rights. The legislation set forth federal policy as follows:

> The use for navigation, in connection with the operation and maintenance of such works herein authorized for construction, of waters arising in states lying wholly or partly west of the ninety-eighth meridian shall be only such use as does not conflict with any beneficial consumptive use, present or future, in states lying wholly or partly west of the ninety-eighth meridian, of such waters for domestic, municipal, stock water, irrigation, mining or industrial purposes.[65]

More recently, western interests have become concerned regarding a federal theory of "sovereign paramount rights." The federal government purchased a ranch in California which was converted into a military training camp. It filed a court case asserting its sovereign paramount rights to all water in the river's watershed ahead of the rights of some twelve thousand other users in the valley. The claim was based on considerations of national defense.[66] The subsequent court decision in favor of the private users was widely acclaimed by water users throughout the West.

Whether or not interstate compacts can provide a solution to many of the interstate conflicts for water in the West remains to be seen. Many of the western states are painfully aware that available water sets an absolute limit to their economic expansion. The fight for water is intense and has been likened to a "giant-size edition of the old West's 'water-hole wars.'"[67] In the biggest water-war of them all, the dispute between Arizona and California, both states are reasonably well satisfied with the existing Colorado River Compact. There is, however, great difference of opinion as to what the Compact means.[68]

[64] Clifford H. Stone, *Adjusting Water Rights Between States*, a paper presented before the Western State Engineers, Great Falls, Mont., September 23, 1940.

[65] Public Law 534, 78th Cong., 2d sess., December 22, 1944, and repeated in Public Law 14, 79th Cong., 1st sess., March 2, 1945.

[66] *The Great Falls Tribune* (Montana), August 4, 1951.

[67] "Why West Fights for Water," *U.S. News and World Report*, April 8, 1949, p. 23.

[68] "Water Fight Rages," *Business Week*, July 10, 1948, p. 32.

It is questionable whether a compact can provide a permanent solution to the needs for water in a dynamic economy. Routt states the problem this way:

> Interstate compacts providing for the allocation of the waters of interstate streams for irrigation and domestic and industrial uses may prove too rigid for easy adaptation to the social and economic development of compacting states. Changes in populations and increases in the industrialization of certain areas within the watershed of an interstate stream may create new demands which were not foreseen by the negotiators of the original agreement.[69]

International Water Agreements

Streams crossing international boundaries are subject to the same problems of control and use as interstate streams. The method of dealing with the problems is quite different. A nation can affect the actions of another nation only through diplomatic relationships or by war. All present-day controversies over the use of the water of international streams have been adjusted through diplomatic channels. If technical matters are involved, and they usually are in controversies over the use of streams, the nations concerned appoint commissions for the assembling of information and the making of recommendations. The resulting recommendations for equitable adjustments in the use of water are usually expressed as a treaty. Differences not settled by negotiation may be arbitrated. The United States has carried on such international negotiations regarding streams on both the Canadian and Mexican boundaries.[70]

[69] Routt, *op. cit.*

[70] For a discussion of the Mexican Water Treaty which divided the waters of the Rio Grande, the Colorado, and the Tijuana rivers between the United States and Mexico, see Martin G. Glaeser, "The Mexican Water Treaty: Part One," *The Journal of Land and Public Utility Economics*, XXII, No. 1 (February, 1946), 1–9; "The Mexican Water Treaty: Part Two," *The Journal of Land and Public Utility Economics*, XXII, No. 4 (November, 1946), 352–62.

CHAPTER 5

Land Problems and Regulations

Irrigation is a spectacular form of land utilization. It appeals to the imagination to make the desert "bloom as the rose" and convert a sagebrush tract into highly cultivated land.[1] The romance of irrigation and its attraction for the individuals seeking a home on the land made it a fertile field for the activities of the promoter. The federal government has taken the interests of the common citizen as the basis of its land policy throughout the history of the nation. Participants in an international conference on family farm policy in 1946 agreed that "public policy in the United States has always favored the family farm as a social and economic unit." The report of the conference goes on to say, however, that "Family farm policy in the United States has never been clearly formulated, and public action has taken a meandering course over the years." [2] Public land policy with the family farm as its cornerstone has been under constant attack by those interested in exploitation for private gain. Public irrigation is no exception. Promoters of all kinds have invaded the field of irrigation development and made more difficult the solution of existing problems as well as creating new ones.

Excess-Land Regulations

The fundamental policy of providing opportunities for the maximum number of actual settlers on the land by limiting acreage to which water will be supplied to that sufficient for the support of a family has been reiterated more than a dozen times over a period of forty years.[3] It will be remembered that the Reclamation Act

[1] Richard T. Ely and George S. Wehrwein, *Land Economics* (New York: The Macmillan Co., 1940), p. 255.

[2] Joseph Ackerman and Marshall Harris (eds.), *Family Farm Policy* (Chicago: University of Chicago Press, 1947), p. 4.

[3] U.S. Department of the Interior, Bureau of Reclamation, *Land Ownership Survey on Federal Reclamation Projects* (Washington, D.C.: Government Printing Office, 1946), p. 29.

of 1902 placed a limit of 160 acres on the amount of land in one ownership for which water could be secured. The Reclamation Extension Act of 1914 reduced the size of an individual holding to a "farm unit" to be determined for each project, but not to exceed 160 acres.

As soon as irrigation development moved from public lands, where the original acreage acquired by an individual could be limited by legislation, the problem of excess lands had to be faced. It was assumed that holders of excess lands who continued to retain more acreage than that for which they could get water were doing so for speculative reasons. It was felt that any inducement to speculate was eliminated because all lands within the project boundaries were subject to construction and operation charges which would make it unprofitable to "hold on" very long.

A landownership study of federal reclamation projects made in 1946 showed that there was relatively little land being held in violation of the limitation of 160 irrigable acres per owner. It should be noted that the law has been interpreted and administered to permit up to 160 acres each for husband and wife, which means that an operating unit on a federal reclamation project can be as large as 320 acres.[4] The study revealed that almost 97 per cent of the ownerships comprised 160 irrigable acres or less, and these ownerships contained 70 per cent of the irrigable acreage on the projects receiving water in 1946. Not all the ownerships with excess acreage were found to be in violation of the reclamation law. When corrections were made for husband and wife ownerships, for various public holdings of a temporary nature, and for land acquired in good faith through inheritance or foreclosure, it was evident that only .83 per cent of all ownerships and 3.7 per cent of the acreage involved were in actual violation of the excess-land limitations.[5]

Attacks on Acreage Limitations

Many attempts have been made to break down the acreage limitations on federal irrigation projects. Four projects have been exempt by congressional action. In 1938, the excess-land provisions were made inapplicable to lands which receive a supplemental water supply from the Colorado-Big Thompson project and which

[4] *Ibid.*, p. 6.

[5] *Ibid.*, pp. 5–7.

have a primary source of irrigation water other than a federal irrigation project.[6]

In addition, two projects in Nevada were exempted from the excess-land provisions by Congress in 1940. It was held that 160 acres were not sufficient for a successful farm operation because the high altitude and early frosts necessitate an economy based largely on hay production.[7]

In 1951, the size of family farm units on the Eden Water Conservation Project in Wyoming was set at from 180 to 220 acres, depending on the class of land. The high elevation of the land, extremes in temperature, short growing season, and only moderately productive soils were mentioned as justification for the size of the units. This project is not a regular reclamation project, however, having been authorized under the Water Conservation and Utilization Act of 1940 which gives a broader discretion than the Reclamation Act.[8]

The most determined opposition to the acreage limitations of federal irrigation law has come from three areas where, from a climatic standpoint, there is the least justification for larger acreages. The economic feasibility of small farms on these three projects should be good in view of the wide variety of crops which can be grown. The three areas which sought to be exempt from acreage limitation are the Central Valley project in California, the San Luis Valley project in Colorado, and the Valley Gravity project in Texas at the mouth of the Rio Grande River.[9] The San Luis Valley project became the fourth area to be exempted by direct action of Congress. In 1952, provision was made for supplemental water necessary to irrigate a maximum of 480 acres per farm unit (Public Law 415, 82d Cong., 2d sess.).

The subject of relaxing acreage limitation on federal irrigation projects is a highly controversial one. Those fighting for its retention contend that any exemption from acreage limitation, except where it can be definitely shown that 160 acres are not sufficient for

[6] U.S. Department of the Interior, Bureau of Reclamation, *Federal Reclamation Laws Annotated* (Washington, D.C.: Government Printing Office, 1947), p. 557.

[7] *Ibid.*, p. 671.

[8] U.S. Department of the Interior, Bureau of Reclamation, Information Service release, November 21, 1951.

[9] Paul S. Taylor, "Central Valley Project: Water and Land," *The Western Political Quarterly*, II, No. 2 (June, 1949), 229–54.

a family farm, will mean the end of the farm home as the objective of federal irrigation development. Probably the most telling argument of those seeking exemption from acreage limitation is that a precedent has been established in the cases cited above. The argument involves much of the basic philosophy in national agricultural policy.[10]

A recent book expressed one viewpoint regarding the acreage limitation in federal reclamation. After pointing out that the purpose of acreage limitation is to insure wide distribution of the benefits arising from federal reclamation, its author attributed opposition to acreage limitation to a desire to secure a greater proportion of the publicly created benefits for private gain.[11] A somewhat different view of the problem is expressed in another recent book. It was pointed out that the application of federal reclamation largely to private lands creates a new set of social policy questions and issues. Such problems as the appraisal and sale of excess lands, the use of interest-free money, and the length of the repayment period all have different significance in the reclamation of private lands on the one hand and in the development of public lands on the other.[12]

It appears that the opposition to acreage limitation arises not so much in cases of public development to benefit nonirrigated private lands as in cases of public development of private lands now irrigated. The most vocal opposition comes from areas where it is proposed to provide supplemental water for lands now irrigated but with an inadequate water supply. It is true, of course, that considerable opposition has developed in certain areas proposed for irrigation where lucrative dryland wheat farming is now done; but it is seldom an organized opposition.

Serious questions may be raised as to whether or not the acreage limitation is too rigid a regulation in view of technological progress in American agriculture. Certainly, consideration can be given to what constitutes an adequate farm unit under varying conditions of irrigation agriculture without abandoning the long-standing philos-

[10] See Mary Montgomery and Marion Clawson, *History of Legislation and Policy Formation of the Central Valley Project*, Bureau of Agricultural Economics, Berkeley, Calif., 1946, pp. 165–67.

[11] Marion Clawson, *Uncle Sam's Acres* (New York: Dodd, Mead & Co., Inc., 1951), p. 194.

[12] Mont H. Saunderson, *Western Land and Water Use* (Norman, Okla.: University of Oklahoma Press, 1950), pp. 158–59.

ophy of the family farm as the basic objective of public development. In many types of farming, the acreage which comprised a family farm in 1902 is inadequate in 1952. This may be particularly true in irrigation areas where extensive agriculture predominates. The fact remains, however, that providing opportunities for family farming is the justification for use of interest-free public funds and must remain so although a more flexible measure of what constitutes a family farm than the arbitrary limitation of 160 acres of irrigable land may be in order.

Land Speculation

It has been pointed out that the acreage limitation on federal irrigation projects was expected to place the lands in the hands of bona fide farm operators and make federal irrigation development an effective part of the national policy to encourage family farms. On the contrary, land speculation in the early years of the national irrigation program came very close to ruining it. Seldom did the first settlers on irrigation projects in the land boom era receive the benefits of government expenditures on irrigation. Instead, speculators who acquired the land before it was irrigated made fortunes.[13] As soon as preliminary surveys were made for a federal irrigation project, speculators would begin filing on the available public lands or purchasing tracts of privately owned land.

Land speculation reached such alarming proportions by 1913 on the twenty-five federal projects which had been initiated up to that time that the Reclamation Service made a study of the situation. It showed that as of 1913 the average price of unimproved land had increased by 759 per cent on the twenty-five projects studied. This tremendous increase in the price of land took place quickly. For eleven of the projects, only seven years had elapsed since construction began. Two other projects had been in existence only six years; another for five years; and another for only one year. For four others, eight years had elapsed; and another four had been started nine years before the survey was made. Only two projects had had a life of ten years.[14]

[13] William E. Warne, "Land Speculation," *Reclamation Era*, XXXIII, No. 8 (August, 1947).
[14] *Ibid.*

These "land boom" prices for project lands caused many bona fide farmers to pass them by. Those individuals who did settle on federal irrigation projects were the victims of an impossible financial situation. The purchase price which a farmer paid the speculator included the value that the government had added by the construction of irrigation works as well as the value of the expected development work on the farm itself of making raw land productive.

It became a common thing for the original settler on the land to find it impossible to carry the heavy financial burden. In many instances, the second farmer to attempt the operation of the place also failed. It became a common saying that "it takes three settlers to make a go of it on an irrigated farm." The third settler to make the venture had been subsidized by the money and labor of his two predecessors. The detrimental effect of speculative land values can be illustrated in present-day irrigation development. Studies have shown that even a 70 or 80 per cent rise in the price of land would increase interest payments on farms on the Frenchman-Cambridge Unit of the Missouri Basin Project in Nebraska and on the Ogden River project in Utah to a point where the farmers would no longer be able to pay for irrigation construction.[15]

Antispeculation Laws

The Fact Finders' Committee recognized the excessive burden of high land prices in the recommendations it made in 1924 (see Chapter 3). The Fact Finders' Act of 1924 contained provisions regarding the qualifications of prospective settlers but no antispeculation provisions. The Interior Department Appropriation Act of 1926 and 1927 provided new antispeculation controls for several specified projects. Legislation to control land speculation on all new irrigated projects was contained in the Omnibus Adjustment Act of 1926. It provided (1) that no water could be delivered upon completion of a new project until contracts had been entered into for payment of construction, operating, and maintenance costs; (2) that excess lands should be appraised in a manner prescribed by the Secretary of the Interior and evaluated without reference to

[15] *Ibid.*

the proposed construction of the irrigation works and that sale prices should not exceed the appraised value; and (3) that until one-half the construction charges against said lands shall have been fully paid, no sale of any such lands shall carry the right to receive water unless and until the purchase price involved in such sale is approved by the Secretary of the Interior.[16]

The Columbia Basin project was made subject to special excess-land provisions and antispeculation controls by the Columbia Basin Anti-Speculation Act of 1937. This legislation was prompted by the problems of securing the breakup of large dryland farming operations in a project area exceeding 1,000,000 acres and to make antispeculation regulations operate with maximum effectiveness.[17] The Act provided that acreage in excess of 40 acres each for husband and wife be considered excess land. Children under eighteen years of age were considered part of the family unit holding the maximum of 80 acres. The acreage per person could be set at less than 40 acres (but not less than 10 acres per person) if the Secretary of the Interior determined the smaller acreage sufficient to support a family. No owner of excess lands could receive water for any part of the lands owned by him so long as he refused to sell such excess lands under terms and conditions satisfactory to the Secretary of the Interior and at prices fixed by appraisal. The United States was given an option to purchase excess lands if it so desired.[18]

The first action of the government to withdraw a water right from a landowner accused of land speculation on the Columbia Basin project occurred in 1949. The settler was accused of violating antispeculation laws by paying $3,500 for 161 acres of land appraised by the government at $1,427.33. A conflict between the Columbia Basin Anti-Speculation Act and state law was involved. The settler bought the land at a sale ordered by the court to settle an estate. State law requires that estate property be sold to the highest bidder. The Bureau of Reclamation notified the settler that it could take no action to restore his water rights until he tried to collect the overpayment.[19]

[16] *Federal Reclamation Laws Annotated, op. cit.*, pp. 318–19.
[17] *Land Ownership Survey on Federal Reclamation Projects, op. cit.*, p. 48.
[18] *Federal Reclamation Laws Annotated, op. cit.*, p. 509.
[19] *The Great Falls Tribune* (Montana), April 2, 1949.

The Lag in Land Utilization

The time period involved in changing land from its dryland use to a condition of full-producing irrigated land is of great significance. The process involves the same consideration of "ripening costs" as in the case of transforming land to any higher use, e.g., subdividing agricultural land for urban use.[20] In the case of irrigation development, it is a more intensive agricultural use rather than a higher use of a different type.

The lag in utilization of irrigated land is evident in many places. For example, according to the sixteenth U.S. Census (1940), *Irrigation of Agricultural Lands*, 1,532,573 acres out of 5,942,958 acres in irrigation enterprises, both public and private, in the Missouri Basin were unirrigated. In other words, one-fourth of the acreage for which irrigation works are available in the Missouri Basin was not irrigated.[21] Of the 5,657,037 irrigable acres in the seventeen western states for which the Bureau of Reclamation was prepared to supply water, slightly less than 15 per cent were not irrigated in 1949.[22] A better indication of the significance of ripening costs may be found in Teele's observation that about 50 per cent of land in all irrigation enterprises remained unirrigated at the end of twenty years from the beginning of construction.[23] Based on the federal census figures for 1910 and 1920, the 50 per cent figure is concerned with a period when a large amount of new irrigation (and particularly the first projects under the Reclamation Act) was in the early stages of agricultural development.

A comprehensive study of the problems involved in securing a closer relationship between agricultural development and irrigation construction was made in California in 1927.[24] Many of the problems discussed are still facing us today. Included are the following:

[20] Ely and Wehrwein, *op. cit.*, pp. 148–50.

[21] Roy E. Huffman, "Considerations Involved in the Agricultural and Economic Feasibility of Irrigation," *Proceedings of the Great Plains Agricultural Council*, Laramie, Wyoming, July 29–31, 1948, pp. 16–22.

[22] U.S. Department of the Interior, *Annual Report of the Secretary of the Interior* (Washington, D.C.: Government Printing Office, June 30, 1950), p. 28.

[23] Ray P. Teele, *The Economics of Land Reclamation in the United States* (Chicago: A. W. Shaw Co., 1927), p. 191.

[24] David Weeks and Charles H. West, *The Problem of Securing Closer Relationship Between Agricultural Development and Irrigation Construction*, California Agricultural Experiment Station Bulletin 435, September, 1927.

1. The relation of irrigation construction to financial conditions.
2. The effect of political influences, booster organizations, and speculation.
3. Increasing size of projects; increasing cost of farm development; increasing difficulty of finding settlers; increasing value of farm lands.
4. The best soils have been put under irrigation.
5. Elements in the cost of the irrigated farm.
   a) The price of the raw unimproved land.
   b) The cost of irrigation construction.
   c) Taxes paid before the land is irrigated.
   d) The cost of improving the land.
   e) Interest costs on all of these items during the period of development.

Policy recommendations included:

1. Creation of projects when in greatest demand.
2. Education to curb unwise political and booster propaganda.
3. Feasibility determinations.
4. A program of planned agricultural development.

Policy recommendation 4 has been urged constantly by those concerned with the agricultural phases of irrigation development. After fifty years of public irrigation development under the Reclamation Act of 1902, there is still no coordinated program of planned agricultural development. The problem of what such a program should include, how far it should go, and the manner in which it should be implemented will be considered in detail in Chapter 8.

Land Classification

The land is of equal importance with water in the development of irrigation projects. Many irrigation projects have failed or faced serious problems because the land was not studied sufficiently before it was determined that a project should be constructed. The type of soil, its susceptibility to irrigation, and the availability of drainage as well as the topography are more important in the ultimate success of irrigation projects than are considerations of engineering feasibility.

A Utah study indicates the maladjustment in resource use which can result when an inadequate classification or a complete lack of

land classification preceded irrigation development. The authors wrote:

> The uneconomic and inefficient combination of available water and productive soil constitutes the most important basic problem confronting the local people. . . . It is also evident that large quantities of water are wasted, particularly noticeable being the large number of duplicating canals and ditches and excessive application of water to certain lands which enjoy an abundant primary right.[25]

Later in the bulletin, these researchers comment:

> The most important single maladjustment shown by the land classification is that good water rights are used on a large acreage of poor soil and that a large acreage of good soil is served by poor water rights. Adjustment in the use of these soil and water resources not only is most important but will most affect the people and the economy of the area.[26]

McMartin describes a Department of Agriculture soils survey of the Belle Fourche Area of South Dakota published in 1908 as having been too little and too late. He goes on to say:

> It was too late because the project was under construction two years before the soils survey was made and water was available eight months before the results of the survey were published. It was too little because the author did not positively state that the clay soils were not irrigable, though it is evident from reading between the lines of the report that he had grave misgivings about their suitability.[27]

The Fact Finders' Act of 1924 recommended classification of lands in federal irrigation projects as the basis for determining repayment ability. Land was divided into six classes with the best irrigable land being class 1. Other irrigable classes were 2, 3, and 4, while class 5 included land believed to be temporarily nonirrigable and class 6 was permanently nonirrigable. This early classification covered existing irrigation projects, many of which had been irrigated for some time. The classification, then, was influenced by such improvements as land leveling which had been carried on and by the quality of management.[28] The Reclamation Act of 1939

[25] George T. Blanch and Clyde E. Stewart, *Utilization of Irrigable Land in the Reservation Area of Unita Basin, Utah*, Utah Agricultural Experiment Station Bulletin 303, March, 1943.

[26] *Ibid.*

[27] Wallace McMartin, "The Economics of Land Classification for Irrigation," *Journal of Farm Economics*, XXXII, No. 4, Part I (November, 1950), 553–70.

[28] *Ibid.*

strengthened the authority for dividing land into several classes for payment of construction.

According to McMartin, the current classification system of the Bureau of Reclamation differs little from the work done under the Fact Finders' Act and seeks to do two things: (1) eliminate areas which cannot pay water charges, and (2) classify irrigable land according to ability to bear construction charges. The system is designed to show that within any one area land of different classes varies in ability to pay for water, and that within a class this ability is generally the same for all parcels of land in the class.[29]

The assumption that all lands in a given class have the same repayment ability is, of course, an oversimplification of the economic significance of the physical factors which determine the class into which land is placed. For example, land which is class 2 for reasons of soil may have an economic potential somewhat different from land which is class 2 for reasons of topography. Recognition has been given to this point in connection with four factors—soil, undulation, size of field, and gradient—in the classification of land in the Crosby-Mohall Unit of the Missouri Basin Project in North Dakota.[30]

In the case of the land classification program on the Columbia Basin Project in Washington, the classification maps have been made available to potential settlers. When land is ranked lower than class 1, the reasons for the lower classification are indicated on the soil map by placing the letter "S" after the classification number if the deficiency is in soil, "T" if the deficiency is in topography, "R" if the lower classification is due to excessive rock in the flow zone, and "D" if the limiting factor is drainage.[31]

The inclusion of land classification in the pre-construction determinations of new irrigation projects is a step which should do much to eliminate some of the problems associated with the physical combination of land and water. The current classification remains, however, primarily a physical one. Closer cooperation with the professional workers concerned with the economic classification of land would help in solving additional problems and further enhance the prospects for success of new irrigation developments.

[29] *Ibid.* [30] *Ibid.*

[31] W. W. Johnston, "Land Classification, Columbia Basin Project, Washington," *Reclamation Era*, XXVI, No. 6, June, 1940.

Land Values Under Irrigation

The valuation of land under irrigation is complicated by the water factor involved. The return to irrigated land from agricultural production is a joint return to land and water. Part of the apparent rent to land is in reality an interest return on a capital investment involving the irrigation structures and distribution system.

The cost of water, then, has a definite effect on the value of land. Selby points out that the more productive and more intensive irrigated farming areas usually support the higher values of both land and water. If the cost of irrigation water were relatively low in such an area, it would be expected that a larger proportion of the joint return would accrue to land. This larger return would be capitalized into a higher land value than in a comparable area with higher water cost. Thus, for areas of equal productivity and equal intensity of farming, an inverse correlation between value of land and cost of water would be expected. A corollary of this theorem is that inflation of land values in an irrigated area absorbs part of the ability of the farmers to pay irrigation costs.[32]

Ownership and Tenure

The fundamental policy in irrigation development of establishing family farms often led to excessive emphasis on putting a maximum number of families on the land at the expense of making the farms too small. As a result, many irrigation projects have gone through a gradual process of enlarging farm units to adequate size. It should be noted, however, that much of the more recent increases in size of irrigated farms may be due to the general tendency for larger acreages associated with mechanization of agriculture.

The Huntley Irrigation Project on the Yellowstone River in southern Montana was established in 1905. As originally divided, there were about 680 farms of 40 acres each on the project. The number of farms had been reduced to 309 farm units in 1936. The tendency through the years has been for most of the farmers to add to the original 40-acre unit. Many have purchased additional acre-

[32] H. E. Selby, "Factors Affecting Value of Land and Water in Irrigated Land," *The Journal of Land and Public Utility Economics*, XXI, No. 3 (August, 1945), 250–58.

age, and many others have rented tracts in addition to that owned. This was indicated by a significant group of owner-renters on the Huntley Project, particularly on the larger farms.[33]

An Idaho study of tenancy on an irrigation project indicated characteristics which are common to tenant farming wherever it exists. Important findings summarized were:[34]

1. Tenants tended to operate larger farms than owners, especially on the poorer soils.
2. In general there was a tendency for tenants to farm the larger places with less intensive crops than did owner-operators.
3. Tenants' crop yields on the various soil types ranged from 2.5 per cent to 15.6 per cent lower than owner-operators' yields.
4. Owner-operators, as a general rule, produced crops of a greater gross value per acre than did the tenants.
5. Tenants kept approximately two-thirds as much productive livestock as owner-operators.

There is a tendency for tenant farming on irrigation projects to be viewed with more alarm than farm tenancy under other circumstances. This attitude may be associated with the fact that irrigation development is supposed to promote farm ownership, and it is something of a shock to discover that it doesn't necessarily do this. Indeed, some characteristics of irrigation farming—e.g., large capital requirements—may make a higher tenancy rate inevitable on irrigated farms.

[33] P. L. Slagsvold, *Land Ownership and Tenure, Huntley Irrigation Project,* Montana Agricultural Experiment Station Bulletin 385, January, 1941.

[34] Paul A. Eke and Harold F. Brown, *Influence of Tenancy on Types of Farming and Agricultural Income by Soil Types, Minadoka Irrigation Project,* Idaho Agricultural Experiment Station Bulletin 222, June, 1937.

CHAPTER 6

Project Organization and Operation

It has been pointed out that early irrigation development was carried on most commonly by individual farmers and by small groups of farmers. As the size of projects—acreage covered, number of farmers, and construction costs—increased, it became evident that definite organization was necessary to facilitate financing and management. The three principal types of irrigation organization, aside from the individual enterprises and the federal reclamation organizations, are the cooperative irrigation companies, the commercial irrigation companies, and the irrigation districts. Many of the early developments went through an evolutionary process from a beginning as small, individual efforts. As they grew in size, they often became partnership enterprises and then cooperatives.[1]

According to the federal irrigation census, cooperative companies, both incorporated and unincorporated, accounted for 27.9 per cent of all land irrigated in 1949, commercial companies for 3.4 per cent, irrigation districts for 17.7 per cent, and Bureau of Reclamation enterprises for 2.4 per cent.[2]

The distribution of irrigation enterprises of different organizational types in the years 1929, 1939, and 1949 was as follows.[3]

	1929	*1939*	*1949*
Individual and Partnership	71,173	86,050	113,358
Cooperative	3,320	4,356	9,374
Irrigation District	363	427	489
Commercial	391	275	446
U.S. Bureau of Reclamation	30	97	37
All other	240	432	222
Totals	75,517	91,637	123,926

[1] Elwood Mead, *Irrigation Institutions* (New York: The Macmillan Co., 1907), pp. 48–52.

[2] *U.S. Census of Agriculture, 1950: Irrigation of Agricultural Lands*, Table 16, p. 58.

[3] *Fifteenth Census of the United States, 1930: Irrigation of Agricultural Lands*, Table 12, p. 54; *Sixteenth Census of the United States, 1940, Irrigation of Agricultural Lands*, Table 6, p. 4; *U.S. Census of Agriculture, 1950, op. cit.*

Cooperative Irrigation Companies

Cooperative irrigation companies are called by a number of different names in various areas of the West including "mutual water companies," "canal companies," and "ditch companies." The cooperative type of irrigation enterprise is a voluntary association of irrigation farmers. The distinctive features of this organization are (1) its nonprofit basis and (2) its essentially private character.[4]

The cooperative irrigation companies are usually incorporated although it is not necessary. Incorporation has many advantages including authority to enter into contracts, incur obligations, appear in court, and hold property. An unincorporated irrigation association must take all action through the cumbersome procedure of securing the consent of all the members.[5]

The corporation is private and voluntary, which means there is no compulsion to join. Individuals who do not wish to do so cannot be compelled to take stock in the organization. Neither can they be denied any rightful proportion of the water supply.[6]

Water rights may be held individually by the stockholders in a cooperative irrigation company or collectively by the company. The purpose of a company is to own the irrigation works and to deliver water to the farm operators. The fact that some farm operators choose to retain their individual water rights rather than deeding them to the corporation need not affect the functioning of the company.[7]

The affairs of a cooperative irrigation company are conducted in accordance with (1) the corporation laws of the state, (2) the articles of incorporation, (3) by-laws of the company, and (4) rules and regulations governing the delivery of water. The stockholders are ordinarily landowners within the area served. In many companies, the quantity of water to which any particular stockholder is entitled during a season depends upon the number of shares of stock owned. This means that a farm operator on land with a high water requirement would need to own more shares per acre than if he were on land requiring less water for a given purpose.[8]

[4] Wells A. Hutchins, *Organization and Operation of Cooperative Irrigation Companies*, Farm Credit Administration Circular C102, August, 1936, p. 2.

[5] *Ibid.*, p. 6.

[6] *Ibid.*, p. 7.

[7] *Ibid.*, p. 10.

[8] *Ibid.*, pp. 12–17.

The stockholders of a cooperative company control the policies of their organization through the board of directors which they elect. Stockholders' meetings are held once a year in most cases. Each stockholder has the right to vote in any election and usually has one vote per share of stock. Few, if any, cooperative irrigation companies provide for one vote per member. Clerical work is the duty of the secretary. In many cooperative companies, the job of secretary is a part-time position. The position is usually filled by a farmer, but some secretaries are lawyers, bankers, or businessmen.[9]

Cooperative or mutual companies have been especially important in California, Colorado, and Utah. This type of organization has also been prominent in Montana, Wyoming, Idaho, and Oregon. From a management standpoint, cooperative companies are equally well suited to small or large developments. Their limitations are more closely associated with the problem of financing because the market for bonds issued by mutual companies is ordinarily a limited one. As a result, the cooperative type of organization ordinarily is unable to finance developments requiring large expenditures of funds. Cooperative companies have been found equally well adapted to new projects and to supplemental development on existing projects.[10]

Commercial Irrigation Companies

The spectacular features of irrigation development resulted in much overoptimism regarding the possibilities for profits if private capital were invested in the building of irrigation projects. A great many commercial irrigation companies came into being during the early days of irrigated agriculture in the West. As a medium for acquiring large profits, however, they fell far short of expectations. We have noted previously in the discussion of land problems that the promoters of commercial enterprises thought the settlers would contract for delivery of water at almost any price because their land was unproductive without it. Instead, it soon became evident that the settlers, with little investment in their land, were in a better

[9] *Ibid.*, pp. 25–33.

[10] Wells A. Hutchins, *Mutual Irrigation Companies*, U.S. Department of Agriculture Technical Bulletin 82, January, 1929. See also Wells A. Hutchins, *Mutual Irrigation Companies in California and Utah*, Farm Credit Administration Bulletin 8, October, 1936.

bargaining position than the commercial irrigation company with a large investment in the irrigation system. In many instances, the settlers waited until the commercial company went bankrupt and then bought the system at a fraction of the original cost to be operated as a cooperative or mutual enterprise.

Hutchins has pointed out that capital stock of commercial companies is the only suitable means of financing new irrigation construction besides the use of public funds. Bonds are not suitable because their value depends on future production.[11] Capital stock is subscribed by individuals who are prepared to take substantial profits or heavy losses, which is an acknowledgment of the speculative nature of the investment. Under the usual set of circumstances, bonds are considered to be a more certain investment.

Commercial irrigation companies have been an important tool in combining the land and water factors in many areas. Companies which set themselves up as ready to supply service to all applicants—within the limits of the available water supply—fall in the classification of utilities. They are commonly called irrigation utilities and are subject to the regulations of the state body which governs other types of utilities. The utility type of organization may be advantageous to the water users during periods of depression if they can secure a ruling from the governing commission which forces a lower rate for water. In the case of cooperative or mutual companies, the water users must carry the actual cost of operation in good years or bad.[12]

Irrigation Districts

It has been noted that the cooperative irrigation companies and commercial irrigation companies are private in character. Irrigation districts are public or quasi-municipal corporations organized under state laws for the purpose of providing a water supply for the irrigations of lands.[13] Irrigation districts are political subdivisions of a state with defined geographical boundaries. They are empowered to issue bonds and to secure revenue from tax assessments levied

[11] Wells A. Hutchins, *Commercial Irrigation Companies,* U.S. Department of Agriculture Technical Bulletin 177, March, 1930, p. 2.

[12] *Ibid.,* p. 4.

[13] Wells A. Hutchins, *Irrigation Districts, Their Organization, Operations and Financing,* U.S. Department of Agriculture Technical Bulletin 254, June, 1931, p. 2.

upon the land. Irrigation districts are created under authority of the state legislature through designated public officials or courts. Formation of a district must be approved by a specified percentage of the landowners holding a specified percentage of the land. The requirements for approval vary from state to state.

The organization of a district is initiated by petition of the owners of the land proposed to be included in the district. In some states, this petition then goes to the county commissioners; in others it goes to the court. A public hearing must be held after which the election is held to vote on formation of a district.

Irrigation districts are organized for the purpose of (1) carrying out new irrigation development and (2) providing supplemental water or buying existing irrigation works. Most irrigation development is now being carried on by the federal government, and formation of an irrigation district is required by the Bureau of Reclamation to act as the agent of the water users in entering into a contract with the government.

Since an irrigation district is a public body which can be brought into existence by popular vote of the landowners, it is obvious that some property owners may find their land included in a district even though they are personally opposed to its formation. It is the democratic process of majority rule. Once formed, an irrigation district is managed by a board of directors or commissioners. Most states provide for three directors although there is some variation in the number, depending on state law or the size of the irrigation district.

Districts are usually organized in divisions with one director elected from each division in order to insure that all portions of the geographic area involved be represented.

State Irrigation District Acts

All of the seventeen western states have provided an aid to irrigation development by delegating to communities one of the functions of the state, the levying of taxes through irrigation districts to raise funds for the construction or purchase of irrigation works and for their maintenance and operation.[14]

[14] Ray P. Teele, *Irrigation in the United States* (New York: Appleton-Century-Crofts, Inc., 1915), p. 75.

The district organization had been used in drainage areas for many years prior to the time it was first applied to irrigation development. The first irrigation district legislation in the United States was enacted by the Territory of Utah in 1865. It was soon evident that the Utah Act had several shortcomings, most important of which was the lack of provision for bond issues. The Utah legislature repealed the law in 1897 and replaced it with a new act in 1909.[15]

California enacted irrigation district laws of various types before devising one that proved satisfactory. The Wright Act, passed in 1887, first included authorization for bond issues and became the model for irrigation district acts in the other sixteen western states.[16]

District acts were enacted as follows:[17]

Arizona	May 18, 1912	New Mexico	March 18, 1909
California	March 7, 1887	North Dakota	March 8, 1917
Colorado	April 12, 1901	Oklahoma	March 29, 1915
Idaho	March 9, 1895	Oregon	February 20, 1895
Kansas	March 10, 1891	South Dakota	March 2, 1917
Montana	March 4, 1907	Texas	April 2, 1917
Nebraska	March 26, 1895	Utah	March 22, 1909
Nevada	March 23, 1891	Washington	March 20, 1890
Wyoming	February 19, 1907		

Federal Irrigation District Act

Public lands within irrigation districts were made subject to state laws by an act of Congress of August 11, 1916. Certain conditions were imposed including approval by the Secretary of the Interior of the plans for the irrigation district. Public lands within approved districts were made subject to taxes levied but nothing in the act "shall be construed as creating any obligations against the United States to pay any of said charges, assessments, or debts incurred." Such obligations become a lien against the public lands but are to be paid by the person who takes up the land.[18]

[15] *Ibid.*, p. 76.

[16] *Ibid.*, p. 76.

[17] Wells A. Hutchins, *Summary of Irrigation District Statutes of Western States*, U.S. Department of Agriculture Miscellaneous Publication 103, January, 1931.

[18] U.S. Department of the Interior, Bureau of Reclamation, *Federal Reclamation Laws Annotated* (Washington, D.C.: Government Printing Office, 1947), pp. 192–96.

Formation of Irrigation Districts

New irrigation districts, almost without exception, are being formed in areas already subject to nonirrigated agricultural uses. Many of the problems associated with the formation of irrigation districts are complicated by this factor. Settlers on earlier irrigation projects, where alternative agricultural possibilities were minor or nonexistent, undoubtedly showed a more unified interest in irrigation development. On the other hand, farm operators in areas where dry farming and ranching are reasonably profitable may not be able to agree on the desirability of forming an irrigation district and irrigating the land.

Opposition to irrigation development in a certain area may or may not be well founded. Too often, the farm and ranch operators in an area proposed for irrigation have not had adequate information on which to base an intelligent decision. The cost factor—operation, maintenance, and construction charges—obviously is a major item influencing the reactions of farmers and ranchers in an area proposed for irrigation. It seems to be a characteristic of federal irrigation development that definite figures on costs are slow in becoming available to the people most concerned. Part of this is probably unavoidable due to shifts in the price level between the time a project is first planned and completion of the final construction phases. Changes in design of various structures and changes in general plans for the project as a whole also make it difficult to predict costs. Every effort should be made, however, to settle on definite cost figures at the earliest possible stage in the planning for new irrigation projects.[19]

Other points besides the cost item are of concern to people in a potential project area. Farmers and ranchers unfamiliar with irrigation will raise many questions regarding the physical, economic, and social effects of a development program. Lack of information regarding a development which everyone knows to be under consideration will invariably lead to a flood of rumors, many of them unfounded and of a damaging nature. Complete, accurate informa-

[19] Joe C. Paulson, "Formation and Operation of Irrigation Districts," *Proceedings of the Seventeenth Annual Meeting of the National Reclamation Association,* Oklahoma City, November 17–19, 1948, pp. 166–67.

tion must be available to the people of any area if a development program is to succeed.[20]

Operation of Irrigation Projects

The operation of an irrigation project presents a wide range of problems, from those of a technical, highly specialized nature to the complex and far-reaching problems of human relations. One writer has described the manager of an irrigation project as follows:

> Like the Old Roman God Janus, who was supposed to be able to look more than one way at once, is the manager of an irrigation project.
>
> He is generally a graduate engineer with an education that enables him to cope with men and handle situations that require a fine technical discernment. Yet he must be a human sort, too, who has not lost the common, practical touch, and is sympathetic with the vexatious problems of all the farmers down to the one on the tail end of the ditch. He must be familiar with tomes of irrigation law, for there is hardly any irrigation project to date that has not fought its way to the top through a torment of legal confusion.
>
> He must have a reserve supply of administrative ability, based if possible on experienced appreciation of the multitudinous duties of employees. He must be a good public relations man, able to deal fairly with water users and their innumerable requests, and with labor, both organized and unorganized.[21]

The ultimate success of an irrigation enterprise may be dependent in large measure on the quality of management. The ability of the operators on the individual farms is probably the only factor which counts more than the ability of the directors of the project in the success of the irrigation enterprise. Efficient management can be of tremendous importance in the optimum utilization of the resources available, particularly water if the supply is short or barely adequate.[22]

[20] Roy E. Huffman, "War and Post-War Problems of Irrigation Planning in the Northern Plains," *Journal of Land and Public Utility Economics*, XIX, No. 4 (November, 1943), 452–63.

[21] Elma Hill Neal, "The Problems of a Project Manager," *Reclamation Era*, XXXIII, No. 8 (August, 1947).

[22] See L. R. Fiock, "How to Conserve Irrigation Water Supplies," *Reclamation Era*, XXXIV, No. 1(January, 1948) and XXXIV, No. 2 (February, 1948). Also, Charles A. Lory, "My Experience as a Ditch Rider," *Reclamation Era*, XXXIII, No. 7 (July, 1947).

Farmer-operated irrigation districts are often plagued by a lack of technical know-how. In some cases, the need for technical assistance is so great that water users are not particularly anxious to have the development agency—the Bureau of Reclamation—step out of the picture and turn a project over to farmer control. More frequently, however, the demands are for the shortest possible period of government supervision and control.

Perhaps the most difficult problem faced in the operation of irrigation organizations has to do with maintaining the distribution system in a condition to function properly. Many irrigation systems have had their efficiency decreased dangerously by weeds and other plant growth in the canals and laterals. The economic significance of this situation is shown by studies carried on by the Bureau of Reclamation. It is estimated that an amount of 150,000 acre-feet of water is lost each year in the Bureau of Reclamation's 14,075 miles of canals and laterals. Projection of these water losses to all irrigation in the seventeen western states (120,386 miles of unlined canals) gives a total of 1,250,000 acre-feet of water annually which is estimated to have a value of $25,500,000.[23]

Types of Organizations Compared

The various types of irrigation organization all possess peculiar advantages for particular circumstances and sets of conditions. All of them have made important contributions to the development of irrigated agriculture in the western states. When considered from the standpoint of their general adaptability, however, each type of organization is characterized by certain limitations as well as specific advantages. Individual developments and partnerships, for example, obviously are limited to small-scale projects.

An important advantage of cooperative irrigation enterprises is their responsiveness to the wishes of the water users who are the owners and operators of the system. This characteristic may create serious problems if immediate desires for low water charges should result in failure to provide for long-run maintenance of the system. Whether or not such a situation arises and becomes a problem will depend on the quality of leadership among the water users. Another

[23] Robert B. Balcom, "Weeds—Water Robbers," *Journal of Soil and Water Conservation*, V, No. 4, Part I (October, 1950), 165–68.

possible area of difficulty for cooperative enterprises may be associated with the availability of technically qualified personnel at the price the organization is willing to pay. In any case, under the cooperative types of organization, the water users determine the quality of service they receive.

Irrigation districts also possess the advantage of being responsive to the wishes of the water users through the elected commissioners. In the case of irrigation districts organized in connection with federal irrigation developments, the Bureau of Reclamation may exercise a considerable voice in the management of the district during the early years of the project. One distinct advantage of this close relationship with the Bureau of Reclamation is to be found in the ready availability of trained technicians in all fields.

Commercial irrigation enterprises can provide whatever quality of service is judged feasible by the management. As in the case of any private business, the maintenance of an adequate level of profits is a primary consideration. This, in turn, will be reflected in water charges as well as the quality of service. As a result, one of the principal problems of the commercial organization is likely to be concerned with maintaining a satisfactory relationship with the water users.

CHAPTER 7

Financing of Irrigation Development

Irrigation development has been plagued with financial difficulties of major proportions because of the large capital expenditures involved. Irrigation development was cheap only in the case of the relatively limited acreage which could be irrigated by small ditches along streams. As soon as irrigated agriculture expanded to lands farther removed from the source of water and required major structures, the financial phase of development became the most difficult of all the many problems.

The Use of Private Capital

The nature of the development of irrigated land created problems not faced in the settlement and building of farms on other types of land. Most early irrigation development was on desert or semiarid lands which were uninhabitable until irrigated. Large expenditures were required in advance of settlement, in fact, often before it was known who would occupy the land and repay the cost of irrigation. On other types of undeveloped land, a settler and his family could develop a farm gradually, through a period of years. The farm development on irrigated land had to be rapid and immediate because of the cost of operation and maintenance in addition to the cost of construction.[1]

Various methods were used to facilitate the building of irrigation enterprises with private capital when the projects were beyond the financial ability of individuals. Early irrigation works in Utah were made possible through the organization of colonies by the Mormon Church. The church furnished money for materials and supplies and the colonists did the work. It received stock for its contribution

[1] R. P. Teele, "The Financing of Non-Governmental Irrigation Enterprises," *The Journal of Land and Public Utility Economics,* II, No. 4 (October, 1926), 425–40.

to the effort and the colonists were given stock for their work. The church disposed of its stock to later settlers.[2]

Utah also passed the first irrigation district law in 1865 as a means of financing irrigation development. Districts organized under the law were authorized to tax the lands within the district boundaries in order to raise money for construction of irrigation works and for operation and maintenance. The irrigation district law contained no provision for the issuing of bonds. The irrigation districts were not successful as a means of financing because a tax sufficient to build irrigation works could not be collected if levied inasmuch as the lands had no productive value until irrigated and brought under cultivation.[3]

Another of the early irrigation developments financed by private capital was the Union Colony of Colorado. This colony was given much publicity and editorial support by Horace Greeley in his *New York Tribune*. The colonists faced a long struggle to achieve financial stability because the cost of land, the cost of irrigation works, and the quantity of water required for irrigation were all very greatly underestimated.[4] Shepherd lists underestimating of construction costs and overestimating of the available water supply as the basis of financial difficulty of projects in Idaho.[5]

Optimism regarding the money-making opportunities in irrigation was such as to attract private entrepreneurs. Many of the projects were promoted during boom periods when construction costs were high.[6] Commercial irrigation enterprises were organized to sell stock and bonds to obtain the funds for construction and to pay off their obligations and make a profit through the sale of water rights alone or with land. The plan contemplated permanent ownership of the works by the construction companies with the users purchasing water. The annual charges would cover the cost of operation and maintenance. Because the land was relatively worthless without water, the construction companies assumed that the landowners must purchase water rights. They underestimated the bargaining position of the landowners whose land represented a small investment and almost no carrying charges. The landowners

[2] *Ibid.* [3] *Ibid.* [4] *Ibid.*

[5] R. E. Shepherd, "The Financing of Irrigation Developments by Private Capital," *Proceedings of the American Society of Civil Engineers*, March, 1926, pp. 401–10.

[6] Willard D. Ellis, "Problems of Financing Land Reclamation," *Agricultural Engineering*, XII, No. 5 (May, 1931), 167–68.

could wait for the construction company to become bankrupt and then buy the irrigation system at a fraction of its actual cost.[7]

The financial difficulties experienced by commercial irrigation enterprises resulted in a reversal of attitude among investors. The feeling of optimism disappeared and no private financing could be secured for irrigation purposes. This blackout on private credit became doubly serious when many of the commercial enterprises found it necessary to refinance their operations. In many instances, the problem was made more difficult because the management of the projects were reluctant to take action. Hutchins pointed out that "Financial settlements are seldom spontaneous and seldom originate with the water users themselves, but usually require constant pushing by creditors or by some interested outside agency." [8] A study of Arizona projects emphasized the importance of the water users taking early action to alleviate financial difficulty.[9]

At the time of the Fact Finders' Report in 1924, and immediately afterward, there was much concern regarding the failure of private capital in irrigation development. One of the interesting proposals made at the time for handling the problem was presented by Shepherd. He proposed that Congress create a corporation on the order of the Federal Land Banks which would be attached to the Department of the Interior or the Department of Agriculture and have as its business "the reclamation of the waste lands of the country, either those of the public domain or State, or in private ownership, and whether by irrigation, drainage or other means . . ." [10] The proposal was advanced as a means of refinancing existing projects, taking reclamation out of politics, and developing a consistent and continuing policy of land reclamation.

The Revolving Fund

The difficulties of securing satisfactory financing of irrigation development by private capital and the increasing size of projects contributed to the demand for governmental action. The Desert Land Act and the Carey Act both failed to solve the problem of financing

[7] Teele, *op. cit.*

[8] Wells A. Hutchins, *Financial Settlements of Defaulting Irrigation Enterprises,* U.S. Department of Agriculture Circular 72, July, 1929.

[9] G. E. P. Smith, *The Financial Rehabilitation of Irrigation and Drainage Districts,* Arizona Agricultural Experiment Station Bulletin 144, April, 1933, p. 123.

[10] Shepherd, *op. cit.*

irrigation development because the land could not be used as security on which to borrow money. Title to the land did not pass to the settler until he met residence requirements in the case of the Desert Land Act and could show actual irrigation under the Carey Act. Neither act made it possible for settlers to secure capital when it was needed, i.e., prior to farm operations.

We have noted previously that the demands for federal action culminated in the Reclamation Act of 1902. The Act established a reclamation fund from the sale and disposal of public lands. The fund was to be used in the developing of irrigation projects with expenditures during each ten-year period to be apportioned among the several states on the basis of income from public land sales within the states. It was assumed that repayments by settlers on the irrigation projects would make the fund a "revolving" one and provide a permanent source of money for irrigation development.

Financial difficulties on federal irrigation projects have been such that the revolving fund failed to revolve.[11] Land speculation, poor selection of projects, greater than estimated construction costs, political interferences, and heavy ripening costs, all contributed to the inability of the settlers to meet their obligations. In 1910, Congress authorized the Secretary of the Treasury to transfer up to $20,000,000 to the reclamation fund for irrigation development.[12] In later years, all pretense of carrying on irrigation construction within an established fund was abandoned and Congress has since made specific appropriations for proposed projects.

Financial Relief to Water Users

The continuing financial difficulty on federal irrigation projects brought numerous legislative changes during succeeding years. The repayment schedule did not take account of the fact that little or no returns were realized during the early years of development. In some cases, farm operators were forced to accept a low price for their produce because the demand for certain crops, particularly alfalfa hay, did not keep pace with supply. The most obvious need was for a lengthening of the repayment period.

[11] Richard T. Ely and George S. Wehrwein, *Land Economics* (New York: The Macmillan Co., 1940), p. 268.

[12] U.S. Department of the Interior, Bureau of Reclamation, *Federal Reclamation Laws Annotated* (Washington, D.C.: Government Printing Office, 1947), p. 127.

Congress amended the original Reclamation Act through passage of the Reclamation Extension Act of 1914 which extended the repayment period from ten to twenty years. Notice was taken of the lack of returns from the farms during the first years of settlement through a system of graduated payments. In the case of new projects, the settler was required to pay 5 per cent of the construction charge at the time of making water-right application or entry. The balance was to be paid in fifteen annual instalments, the first five being of 5 per cent each and the last ten of 7 per cent each. The first of the fifteen annual payments was due on December 1 of the fifth calendar year after the initial payment.[13]

A different schedule applied to lands already under the Reclamation Act at the time the Extension Act was passed. The settler was to pay the construction charge remaining unpaid in twenty annual payments. The first four instalments were to be 4 per cent each and repayment was to be completed with fourteen payments of 6 per cent each.[14]

The Extension Act also provided that no water should be delivered to the lands of any water-right applicant or entryman who was in arrears for more than one calendar year for the payment of any charge for operation and maintenance or any annual construction charge and penalties.[15] This provision created a serious administrative problem on the projects. Settlers who were unable to secure water for their crops were bitter in their denunciation of the Act and loud in their demands for relief.

By terms of an Act of March 31, 1922, the Secretary of the Interior was authorized, at his discretion, to extend the date of payment of any construction charge for a period not to exceed one year from December 31, 1922.[16] In addition this Act authorized the Secretary, after due investigation, to furnish water on federal irrigation projects during the irrigation season of 1922 to landowners or entrymen who were in arrears for more than one calendar year in the payment of any operation and maintenance or construction charges.[17]

The situation did not improve during the next year and on February 28, 1923, Congress amended its action of the previous year to

[13] *Ibid.*, p. 161.
[14] *Ibid.*, p. 162.
[15] *Ibid.*, p. 168.
[16] *Ibid.*, p. 239.
[17] *Ibid.*, p. 240.

extend for another year the time allowed for payment of charges due on reclamation projects.[18] Still later, by terms of an Act of May 9, 1924, the Secretary of the Interior was authorized to grant similar deferments on the payment of charges owed by water users on irrigation projects being constructed or operated and maintained under the direction of the Commissioner of Indian Affairs.[19]

It will be remembered that the Fact Finders' Committee had recommended that productivity of the land should be the basis for the annual repayments of construction costs and that the annual per acre repayment charge should be 5 per cent of the average annual gross income per acre.[20] The Fact Finders' Act provided, among other things, that irrigable lands of new projects be classified and different construction charges be fixed against the different classes of land and that construction charges be based on productive power of the land with the annual charge being 5 per cent of the average gross annual acre income for the ten calendar years first preceding or for all years of record if fewer than ten years were available, annual payments continuing until the total construction charges were paid.[21]

Further relief to water users was contained in the Omnibus Adjustment Act of May 25, 1926. Adjustment of water-right charges on specified projects scattered throughout the western states was provided for. Deductions from total costs were permitted in the case of construction charges on lands judged permanently unproductive on the various projects. Suspension of charges was provided for in the case of lands classed as temporarily unproductive.[22]

The financial difficulty of farmers on federal irrigation projects was intensified during the depression of the 1930's. By an Act of April 1, 1932, Congress authorized a moratorium on payment of regular construction charges for the calendar year of 1931 and 50 per cent of that due for 1932.[23] A year later on March 3, 1933, provisions of the Act of April 1, 1932, were extended to include the other half of the payments due for 1932 and to place a moratorium on construction charges for 1933.[24] The series of moratoria was

[18] *Ibid.*, p. 259. [19] *Ibid.*, p. 263.

[20] Ray P. Teele, *The Economics of Land Reclamation in the United States* (Chicago: A. W. Shaw Co., 1927), pp. 77–78; also John A. Widtsoe, *Success on Irrigation Projects* (New York: John Wiley & Sons, Inc., 1928).

[21] *Federal Reclamation Laws Annotated, op. cit.*, pp. 274–75.

[22] *Ibid.*, p. 313. [23] *Ibid.*, p. 414. [24] *Ibid.*, p. 431.

further extended to include construction charges for 1934 by an Act of March 27, 1934.[25] Construction charges for 1935 took their place in the series when Congress passed the Act of June 13, 1935.[26] The sequence of moratoria was broken and 1936 and 1937 passed without specific relief from Congress. By an Act of May 31, 1939, however, the Secretary of the Interior was authorized to extend the period of time for payment of construction charges for 1938 in order that settlers might receive water for the 1939 season. Any extension of time was to be based on a careful study of the ability of water users to make payment.[27]

Joint Liability

One feature of the repayment program on federal irrigation projects which is peculiar to that type of development is the provision for "joint liability." The system makes all the land of a project jointly liable for the whole cost of the project instead of having each acre liable only for its own share of the cost. Joint liability is established through the organization of irrigation districts which contract with the government for repayment of construction costs. By requiring that an irrigation district be organized before any construction of works begins, the government is able to force all projects to accept joint liability.

Arguments advanced by the government to justify this procedure were (1) the districts could collect payments more efficiently and conveniently through their taxing power, and (2) the construction costs of a federal irrigation project are a first lien on the land, which would prevent the settler from securing a loan under the Federal Farm Loan Act which also requires a first mortgage. If the obligation to the government is assumed by an irrigation district, it does not constitute a first mortgage on the land and, therefore, it would be possible to get other loans requiring a first mortgage. However, Teele emphasizes that the real aim of government administrators was to substitute joint liability for liens on individual farms.[28]

It is not surprising that water users object to joint liability. It is contrary to general business principles to ask one purchaser to assume an obligation to pay a share of losses that may occur in the

[25] *Ibid.*, p. 450.
[26] *Ibid.*, p. 466.
[27] *Ibid.*, p. 572.
[28] Teele, *op. cit.*, p. 128.

future through the default of others. In effect, if there are delinquent obligations on any lands within a project, no landholder can secure a clear title to his land even though his own charges may be paid in full. It should be noted, however, that without the protection of the joint liability system, the government would have to set its charges sufficiently high to cover probable defaults.[29]

With regard to the effectiveness of the joint liability clause, Smith wrote:

> If there are but few delinquencies on the part of landowners, the remaining landowners carry the added burden without great difficulty. But, if there are a great many farmers delinquent in taxes and assessments, the remaining farmers who perhaps might continue paying, become discouraged and rebellious and refuse to make any more payments. It becomes apparent to them that the load is, or soon will be, greater than they can bear, and they know that it is not advisable "to throw good money after bad." Consequently, in a time of general failure, the joint liability feature defeats its own purpose.[30]

Subsidy in Irrigation Development

It has been estimated that two persons will become established in nonfarming endeavors as the result of irrigation development for each person actually on the farms of an irrigation project. A former Commissioner of Reclamation stated that the economic destinies of one out of every ten Americans depend on irrigated areas and the towns and cities which have sprung up on irrigation developments or nearby. Los Angeles, Phoenix, Salt Lake City, and Denver are listed as large cities having their foundations in irrigation development.[31]

The extent to which the federal government should provide subsidy for irrigation development has been a controversial subject for many years.[32] The problem involves broad issues related to national agricultural and land policy. Several of these issues will be considered in a later chapter. Suffice it to say at this point that one can argue quite effectively that subsidy in irrigation development is in no way different from the practice of spending nonreimbursable

[29] *Ibid.*, p. 129.

[30] Smith, *op. cit.*, pp. 132–33.

[31] John C. Page, "The Final Frontier and What It Means," *Land Policy Review*, V, No. 1 (January, 1942), 6–12.

[32] R. P. Teele, "The Federal Subsidy in Land Reclamation," *The Journal of Land and Public Utility Economics*, III, No. 4 (November, 1927), 337–42.

public funds on flood control and navigation from which individuals and private business benefit.

There are those spokesmen for irrigation development who will insist that subsidy is not wanted and then, in the same breath, talk about the necessity for "writing off" part of the construction costs on old and new irrigation projects. There seems to be a reluctance on the part of many of these spokesmen to recognize the obvious fact that agriculture can never repay the charges on some irrigation developments. We need to admit that, if present high-cost projects are to be constructed, subsidy will be necessary. Whether or not such projects should be constructed is another matter and one which we will consider later on. We will also find a new method of allocating costs among all the users of water, i.e., the multiple-purpose concept.

Some other nations appear to have taken a more realistic look at the problem. It should be noted that the viewpoint in these other countries may be influenced by different problems of population-land relationship, although the situation in Canada is, presumably, similar to that in the United States. In Canada, for example, it is proposed that the new settler on irrigation projects should receive water free of charge for one or two years. Also, the construction costs charged to the settler should be kept low, the payments should not start until the third year, and the rates of interest payable on the unpaid balance should be very low. These objectives would be achieved through construction of storage reservoirs, diversion dams, main canals, and connecting canals by the dominion government as a contribution to irrigation. The provincial governments would construct the distribution system, provide the free water service, and the agricultural advice, and only charge a nominal amount, from $10 to $15 per irrigable acre, payable at the rate of $.50 per acre per year for the water rights.[33] In Canada, the Prairie Farm Rehabilitation Administration functions in much the same way as the Bureau of Reclamation in the United States.

Australia is another nation where a substantial part of the cost of water supply and irrigation works is borne by the state. This step was taken when it was realized that the ideal of the water users bearing the full cost of constructing and operating works could

[33] P. M. Sauder, "Irrigation in the Province of Alberta, Canada," *Reclamation Era*, XXXIV, No. 5 (May, 1948).

seldom be attained.[34] The Philippine government, which has patterned its irrigation program closely on the United States model, is also finding it necessary to move in the direction of greater government contribution to irrigation development.[35]

Presumably, national governments carrying on such policies as those cited have determined that the action is in the national interest. With respect to the subsidy issue and the national interest, the President's Water Resources Policy Commission wrote:

> . . . Federal water resources policy merely needs strengthening at two points: (a) all private beneficiaries should be required to return the costs incurred to serve them, and (b) social benefits and national interests should be clearly differentiated from those for which reimbursement would be required, and appropriations be made accordingly after full Congressional discussion. The charge of subsidy would then be invalid. Where the public interest is clearly established, public expenditures to promote it cannot properly be regarded as subsidies.[36]

Conservancy Districts

It is probable that, in advocating the spreading of repayment obligations over all those who benefit from irrigation, most individuals are thinking of the local benefits which are more obvious than the national benefits. The effects of a new irrigation development on the number and size of retail-business establishments in the area are plain to all. The use of water jointly with irrigation by other local interests—such as municipal water—has resulted in several cases where those other interests have shouldered part of the financial burden. The means by which the costs are spread over all the uses benefiting is known as a conservation district or "conservancy district." These districts are especially created subdivisions of the state which cut across the boundaries of other local units of government. Their greatest advantage lies in being fitted to particular land use areas or natural resource developments. Through the taxing power, they are able to recover construction and development costs. Conservancy districts have been used to promote irriga-

[34] Lester A. Robb, "Irrigation in Australia," *Reclamation Era*, XXXIV, No. 1 (January, 1948).

[35] Paul V. McNutt, "Irrigation in the Philippines," *Reclamation Era*, XXXIII, No. 3 (March, 1947).

[36] President's Water Resources Policy Commission, Report of, Vol. I: *A Water Policy for the American People* (Washington, D.C.: Government Printing Office, 1950), p. 78.

tion, drainage, flood control, water power development, and soil conservation.[37]

State authorization for conservancy districts varies from the widely used, general enabling act type of legislation in effect in Colorado to the situation in North Dakota where the legislature authorized one conservancy district involving specified counties.

Interest on Irrigation Obligations

We have pointed out previously that a number of factors in the original selection and planning of irrigation projects contributed to the repayment difficulties of the settlers. Many place some emphasis, too, on the fact that the federal government does not charge interest on delinquent repayment obligations. Proponents of charging delinquent settlers interest argued that any sensible person would always take care of his interest-bearing obligations first.[38] It followed that irrigation repayment costs would always be paid last, if at all. During the course of congressional debate on the Reclamation Extension Act, it became evident that the farm operators were unable to pay interest. Opponents of western irrigation development seized this point as proof that expenditure of public funds on such projects was not justified because the capital invested would not return interest. Supporters of interest-free money argued that it was in no way different from the expenditure of public funds on river and harbor development for the benefit of private users.[39]

The principle of interest-free money appears to be firmly established as a part of federal reclamation policy. The President's Water Resources Policy Commission recommended that the primary beneficiaries of reclamation activities should continue to repay their obligations to the government without interest. The Commission footnoted its recommendation with the comment that federal, state, and local governments collect much larger revenues because irrigation increases the taxable valuation of farm lands and enhances community incomes generally.[40]

[37] Ely and Wehrwein, *op. cit.*, pp. 476–77.

[38] John W. Haw, "Reclamation's New Look," *Proceedings of the Seventeenth Annual Meeting of the National Reclamation Association*, Oklahoma City, November 17–19, 1948, pp. 62–75.

[39] B. H. Hibbard, *A History of the Public Land Policies* (New York: Peter Smith, 1939), p. 446.

[40] President's Water Resources Policy Commission, Report of, *op. cit.*, Vol. I, p. 84.

Repayment Experience

The periodic and, at times, almost constant financial difficulties of the settlers on federal irrigation projects indicate a far from rosy repayment history. It will be remembered that the ten-year repayment period of the Reclamation Act of 1902 was lengthened to twenty years by the Extension Act of 1914. The Fact Finders' Act of 1924 provided for an indefinite period of repayment, but the Omnibus Adjustment Act of 1926 substituted the present forty-year repayment plan.

By 1918, the federal government had made water available to settlers on twenty-seven projects. On the basis of the repayment experience to June 30, 1938, Joss has classified the twenty-seven projects as follows:

Five federal irrigation projects have been abandoned as a result of congressional authorization. It was concluded that on none of these was there any possibility for the settlers to pay out and that the government would only lose more by additional expenditures on them.

On the basis of their past repayment record, it is estimated that four projects will require more than two hundred and fifty years each to pay out the total amount repayable June 30, 1938. Five other projects will require from one hundred and twenty-five to two hundred and fifty years for the payment of the total amount repayable if they continue at their present rate. Six projects will require from seventy-five to one hundred and twenty-five years and the remaining seven projects can pay out in less than seventy-five years on the basis of past experience.[41]

The twenty-two projects still in operation in 1938 had paid 26 per cent of the total amount repayable. The four projects with the poorest repayment records had paid only 5 per cent of the amount levied against them. The total amount of charges written off by various congressional acts amounts to 8 per cent of the net cost of the first twenty-seven projects. The entire cost of the five abandoned projects has been written off, and the write-offs on presently operating projects range up to 70 per cent in one case.[42]

[41] Alexander Joss, "Repayment Experience on Federal Reclamation Projects," *Journal of Farm Economics,* XXVII, No. 1 (February, 1945), 153–67.

[42] *Ibid.*

Variable Repayment

The basic problem in repayment of public funds expended on federal irrigation projects is to devise a repayment schedule which conforms to the settler's ability to pay. To accomplish this, the schedule would have to take into account both physical and economic variations. The previously discussed provision of the Fact Finders' Act stating that annual payments should be 5 per cent of the average gross annual acre income did not take into account all the consequences of variations in the economic system. The basing of annual charges on gross annual income considered only one side of the farmers' operations. There was no measuring of the effects of costs of operations on the settlers' ability to pay.

It is characteristic of business cycles that costs lag behind incomes during the downturn or recession phase. Agriculture is particularly subject to this squeeze between income and costs because it sells under conditions most nearly approaching pure competition of any phase of the economy and buys goods produced under varying conditions of imperfect competition. In other words, during periods of recession and depression, the farmers' ability to repay irrigation costs as indicated by net income will be somewhat less favorable than as shown by gross income. It is also true that prices for farm commodities tend to outrun cost items during the other half of the business cycle and, therefore, repayment charges can be higher during periods of recovery and prosperity.

The Reclamation Project Act of 1939 set up a variable repayment plan but kept the *gross* income basis of computation.[43] The problem of computing repayment charges on the basis of *net* farm income is not a simple one. Indices of prices received by farm operators are generally available and widely used. The general index of prices for farm commodities in the western states is not entirely typical, however, of irrigated farm income. In most of the western states, for example, the general index of prices received is too heavily weighted with wheat to be representative of irrigation farming and not weighted heavily enough with sugar beets, dry beans, and other specialty crops. Indices of prices paid by farmers are available in only a few states; they need to be constructed for all the western states. Indices of prices received and prices paid can form the basis for a variable repayment plan which ties annual charges

[43] *Federal Reclamation Laws Annotated, op. cit.*, pp. 588–604.

to changes in net income—a true measure of ability to pay.

Even the best designed variable repayment contract does not guarantee that the water users will be able to repay the irrigation construction costs within the maximum number of years permitted by law. The period of repayment for many projects for which financial readjustment is being considered will exceed the present legal limit of forty years, and such a situation will require congressional approval.[44]

One of the most controversial features of existing reclamation law has to do with repayment. Section 9 (e) of the Reclamation Project Act of 1939 provides that, in lieu of entering into a regular repayment contract, the Secretary of the Interior may, at his discretion, enter into either short- or long-term contracts to furnish water for irrigation purposes.[45] This type of contract places the Bureau of Reclamation very much in the category of a public utility. Irrigation interests have voiced their bitter opposition to what they view as a move in the direction of perpetual government ownership of irrigation systems. In those instances where the so-called 9 (e) contracts have been used, the situation is probably symptomatic of the fact that the water users cannot pay the construction costs within the forty years now permitted.

Repayment of construction costs cannot be considered apart from the annual operation and maintenance (O & M) charges associated with an irrigation project. Together, they comprise the total irrigation costs which the water users are expected to meet. High annual costs for operating and maintaining an irrigation system may make it difficult for the water users to pay construction charges on schedule. Some project lands may be capable of carrying only the O & M charges. In cases where such low-productivity lands are scattered throughout the project and can be served with the existing irrigation system, it may be desirable to deliver water to them even though they are unable to repay construction costs. The collection of O & M charges on such low-productivity lands may reduce the average O & M charges on all lands in the project. Such a policy, obviously, could not be justified if the delivery of water to lands incapable of paying construction costs required additional investment in the irrigation system.

[44] Roland V. Snow, "Project Repayment Contracts—Custom Tailored," *Reclamation Era*, XXXIV, No. 11 (November, 1948).

[45] *Federal Reclamation Laws Annotated, op. cit.*, p. 600.

CHAPTER 8

The Development of Irrigated Farms

It has been noted in relation to a number of points that the consistently stated goal of federal land reclamation is the providing of opportunity for the building of family farms. It has also been noted that this goal is in harmony with the long-run agricultural policy of the United States. Johnson comments as follows on the family farm in national agricultural policy:

> Owner-operatorship of family farms long has been one of the principal goals of agricultural policy in this country. Certain welfare values associated with the family farm are harder to obtain in alternative kinds of organization in farming. It seems desirable, therefore, to maintain the family farm as the *prevailing business unit* in agriculture. . . .
>
> All available evidence indicates that family-operated farms which are large enough to utilize labor saving equipment and other improved techniques usually can compete effectively with large-scale units. Farms too small to make efficient use of these improvements, however, may operate at a considerable disadvantage compared with larger units. Nevertheless, many persons find their best opportunity in agriculture, although for reasons of health or other factors, they are unable to operate family farms of efficient size. The farm size array, therefore, will need to include some *small-scale* units, but special types of assistance should be developed to improve operating and living conditions on such farms. . . .[1]

The term "family farm" means many things to many people. To some the term seems to be synonymous with subsistence farming. The subject of subsistence agriculture received much attention during the depression of the 1930's when unemployment was a major problem. It is worth noting that the practicing crusaders for subsistence farming have other sources of income making it possible for them to purchase things they could not afford if they were wholly dependent on the type of farm operations they advocate.

[1] Sherman E. Johnson, "Technological Changes and the Future of Rural Life," *Journal of Farm Economics*, XXXII, No. 2 (May, 1950), 225–39.

M. L. Wilson, who administered the federal government program in aid of subsistence homesteads during the depression, had this to say: "Personally I dislike the word 'subsistence.' To me it signifies something below the level of an existence and certainly something quite beneath the standard of living which should be within the grasp of men willing to give honest labor to society in this age of science." [2] Dr. Wilson went on to say that the subsistence homestead idea must be associated with decentralization of industry in order that the farm income be supplemented by income from other sources.

Certainly, a subsistence basis for the farm family is foreign to the American ideal. The subsistence idea can be eliminated from consideration of what constitutes a family farm. There remains, however, the difficult task of defining what should be the meaning of the family farm, a term which is used with considerable looseness.

Defining the Family Farm

A variety of definitions can be found for the family farm. Most of them agree on a number of basic criteria for the family farm and differ on features which are by no means of minor importance. Most of the definitions include terms which are themselves indefinite. Johnson and Associates wrote:

> The family farm may be defined as one for which the principal source of labor is the farm family, and one which is of sufficient size and productivity to pay expenses, including maintenance of the farm, furnish an income that will provide a comfortable living for a farm family, including food and shelter, medical care, education and recreation, and permit the accumulation of a reserve sufficient to meet the needs of old age.[3]

An international conference on family-farm policy failed to reach complete agreement as to what constitutes a family farm. In some countries the concept of family farm includes farms which operate on nearly a subsistence level, while in others it includes farms em-

[2] M. L. Wilson, "The Place of Subsistence Homesteads in Our National Economy," *Journal of Farm Economics*, XVI, No. 1 (January, 1934), 73–84.

[3] Sherman E. Johnson and Associates, *Managing a Farm*, p. 23. Copyright, 1946, D. Van Nostrand Co., Inc., New York.

ploying outside labor. The conference did set forth some general criteria:[4]

1. Management must reside largely in the family that supplies the labor.
2. The amount of land and capital must be sufficient to absorb efficiently the labor of a typical farm family.
3. With reference to control, the farm family must largely direct its own destiny in the use of all the resources on a unit that meets the foregoing standards.

There are two important parts of the usual definition of the family farm which are often indefinite in themselves. They are (1) the distribution of labor between that supplied by the family and that which is hired and (2) the acceptable level of income for the farm family. With respect to the source of labor, most definitions of the family farm stipulate that hired labor be only that incidental to seasonal demands. Some writers place no arbitrary upper limit on the number of hired laborers which a farm may use and still remain in the family-farm classification. Rather, they emphasize the relationship between family labor and hired labor—whether or not they work together. By this criterion, if the management function is not separated administratively from the labor function, the unit may be classified as a family farm. It has been pointed out, however, that the employer-employee relationship in agriculture is not different from that in other industries.[5] As soon as two or three workers are found on the same farm, the agricultural labor is in much the same position as employed persons in other industries.

A Seminar on Rural Life at Columbia University stated as one of the criteria of the family farm that the operator and his family furnish one-half or more of the labor input. It was pointed out, however, that this fails to take three things into account.

> First: On many of today's larger, specialized farms, management has become far more important and time consuming than it was half a century ago. Accounting procedures have become necessary, as have other overhead activities. The good farmer spends more time at his desk than ever before . . .

[4] Joseph Ackerman and Marshall Harris (ed.), *Family Farm Policy* (Chicago: University of Chicago Press, 1947), p. 7.

[5] Orlin J. Scoville, "Measuring the Family Farm," *Journal of Farm Economics*, XXIX, No. 2 (May, 1947), 506–19.

Second: Some specialized crops, especially fruits and vegetables, require large amounts of wage labor for brief periods, but the total man hours may be more than those of the operator and his family even though employed full time for the whole year.

Third: The criterion laid down was strenuously resisted by . . . farmers who failed to meet it. This resistance is based largely on psychological considerations. The feeling of these operators toward their acres, toward land, their profession, the communities and rural life in general are identical with those of the other two-thirds who supply more than half the labor input on their farms. . . .[6]

The idea that a family farm should be a "two-man farm" has been advanced by O. E. Baker. In the ordinary course of events, a son will be of an age to farm for himself for as much as fifteen to twenty-five years before the father is ready to retire from the business completely. If family farms are to be passed from one generation to another in orderly fashion, the farms should be large enough to provide a living for, and utilize the labor of, two grown men and their families.[7]

The amount of income is likewise a crucial point in the defining of the family farm. Scoville wrote:

One of the most common of these definitions is in terms of adequate income, but this by itself is not a satisfactory measure. To arrive at "adequate income" the usual approach is to set up a list of goods and services a typical family should have, determine the income needed to cover the cost of these, and then describe the size and type of farm that will give this income with average management. Setting up the essential needs of families is a rather arbitrary procedure. There is wide variation between regions and individual families in the goods and services the families themselves consider essential.[8]

The method used in the determination of the standards of living that should be sponsored in the establishment of new farms on the Columbia Basin Irrigation Project has been described by Fisher.[9] The basic assumption was that

. . . there was in every family's disposition of its income a competition between saving and spending. It was further assumed that

[6] Edmund de S. Brunner, "Case Studies of Family Farms," Columbia University Seminar on Rural Life (1947–48), Columbia University, N.Y., pp. 7–8.

[7] O. E. Baker, Ralph Borsodi, and M. L. Wilson, *Agriculture in Modern Life,* (New York: Harper & Bros., 1939), p. 49.

[8] Scoville, *op. cit.*

[9] Lloyd H. Fisher, "What Is a Minimum Adequate Farm Income?" *Journal of Farm Economics,* XXV, No. 3 (August, 1943), 662–70.

> saving would not appear as an important element in this allocation of income until the minimum requirements of family living, as the family defined these requirements, were met. It followed, therefore, that there ought to be an income level below which the characteristic of income groups would be an excess of expenditure over income and above which there would be an excess of income over expenditure.[10]

The study involved a sample drawn from 948 full-time, native-born farm families operating small general farms in the Pacific Northwest. The income level at which income and expenditure approximately balanced was found to be in the income class $1,000 to $1,250. In the income class $2,500 to $3,000 little or no additional income was spent for family living and all additional income was saved. It was suggested that the first relationship might well set the lower limit on income objectives in agricultural planning while the second relationship might set the upper limit.

The next step was to settle upon an income in the rather broad area between the lower and upper limits. Using data derived from the Consumer Purchases Study in the Pacific Northwest, a table was constructed showing the percentage of solvent farms at various levels of farm income. A solvent farm was defined as one having an excess of income over expenditures. In the income class at the lower limit, $1,000 to $1,250, the solvency rate was 70.3 per cent while at the upper limit, $2,500 to $3,000, the solvency rate was 95 per cent.

Applying this information to farms which might be developed on 100,000 acres of Columbia Basin lands, Fisher points out that 2,500 farms of 40 acres each could be organized. Such farms would have $875 available annually for family living with a solvency rate of 52 per cent. Subdivision of the land on the basis of 40 acres per farm would result in 1,300 solvent and 1,200 insolvent farms, hardly a desirable social goal. If the size of farms was increased to 60 acres, the number of solvent farms decreased by 128 and the number of insolvent farms decreased by 705. Fisher says:

> As farm size is increased, the total number of farms decreases, the family income increases, the solvency rate increases, and the total number of both solvent and insolvent farms decreases. The essence of the method proposed here lies in the fact that the number of solvent farms has a different rate of decrease than does the number of insolvent farms.[11]

[10] *Ibid.*

[11] *Ibid.*

The objective is not to maximize the number of solvent farms without reference to the insolvent farms. That could be accomplished on 100,000 acres of Columbia Basin land by establishing farms of 40 acres. The objective is to establish the maximum net number of solvent farms—the greatest excess of solvent farms over insolvent farms. In the situation outlined by Fisher, this could be accomplished by establishing 80-acre farms of which 1,009 would be solvent and 241 insolvent or a net of 768 solvent farms. This means a total of only 1,250 farms for the 100,000 acres of land rather than 2,500 farms of 40 acres each.

The above is indicative of what would happen on Columbia Basin farms if the too-often-stressed goal is followed of placing the maximum number of settlers on the irrigable lands. There is much to recommend the procedure outlined by Fisher. It places the measure of the acceptable size of farm on income, which is where it belongs. Of importance is the fact that, through the consumer purchases study, it relates the income determination to the locality where the problem situation exists. It is conceivable, however, that the farms included in a consumer purchases study should be viewed from the standpoint of whether the income-expenditure pattern is one which permits the maintenance of adequate living conditions. For if the standard of living on the farms included in the consumer purchases study is low, it will be low, too, on any new farms based on that study. In an earlier attempt to visualize the family farm, the writer suggested the following criteria in question form:[12]

> First, does the farm provide *comforts and conveniences in the home* equal to those enjoyed by the average of families securing their living from other occupations?
>
> Second, does the farm provide *educational and recreational opportunities* equal to those enjoyed by other families in the community?
>
> Third, does the farm provide an *acceptable standard of nutrition and health?*
>
> Fourth, does the farm provide for *security and stability in operations* from year to year?
>
> Fifth, does the farm provide for *family succession in operation?*
>
> Sixth, does the farm provide an *opportunity for conservation farming?*

[12] Roy E. Huffman, "On the Plains, Small Farms May Be Big," *The Land*, VII. No. 3 (Autumn, 1948), 452–54.

What, then, should be the criteria for determining the combination of resources that fits the family-farm ideal? What measures of the labor factor and of farm income should be used? In the opinion of the writer, the emphasis should be placed on income. If some consideration of the labor factor is deemed essential, a practical guide might be to set the goal at two man-years of labor per farm. Assuming that the head of the family devoted full time to farm work, such a farm would satisfy the stipulation that the family supply 50 per cent or more of the annual labor requirement. With some adjustment, it might also satisfy the need for two-man farms for father-son teams.

With respect to the level of farm income, the procedure used in the Columbia Basin investigations should provide a defensible empirical basis for planning the size of farms on new irrigated lands. Once the analysis of an area similar to that proposed for irrigation has indicated the level of income and size of farm necessary, the proposed agricultural organization should be measured against a set of judgment criteria such as the six questions suggested above. In other words, organizing the agriculture of a new irrigated area on the same income level as agriculture nearby does not guarantee that all social goals will be fulfilled. It depends on the situation in the area from which the basic data are drawn.

The Pioneer Settler

The settler on a typical irrigation project is a true pioneer in every sense of the word. The family which undertakes to develop a farm on a reclamation project is faced with the same problems that have challenged settlers on raw land since the earliest pioneer days on the Atlantic Coast.

Most of the persons who go into a new irrigation project are strangers to the area. Even if they are experienced in irrigation agriculture, many conditions in the new environment will be different from those previously encountered. However, many settlers will have had no experience with irrigation farming. They must learn new techniques and methods at the same time that they are facing the many problems of providing buildings and other facilities, equipping the farm with machinery and livestock, and preparing the land to receive irrigation water.

How much of a pioneer existence should the settler on a present-day irrigation project be expected to lead? Should he be expected to make his way on rough, unleveled land, part of which may be covered with timber or sagebrush? Many people will say yes and point out how the pioneers of an earlier day developed farms against even greater odds. True, everyone thrills to the tales of how those stalwart settlers hewed a farm from the wilderness and fought off the Indians at the same time. It would seem, however, that to insist that the settlers on new irrigation projects undergo the same hardships would be another example of our all-too-frequent tendency to guide public policy by outmoded conditions and experiences. The settler on a new irrigation project doesn't have to fight Indians but he does have to meet very difficult problems in securing the machinery, livestock, and building facilities that are necessary for survival in our highly competitive modern agriculture.[13]

Development Before Settlement

The traditional limit to public irrigation development is the building of a distribution system which delivers water to the high point on each farm unit. From there on, the farm operator is on his own. The idea that public action should go beyond that of delivering water to the high point on the farm is not new. We noted in Chapter 3 that the Fact Finders' Commission of 1924 recommended, among other things, these specific actions:

1. That cost of land leveling and farm distribution systems be made a part of construction costs.
2. That loans to settlers for development be a part of the federal irrigation program.
3. That credit be available to settlers for financing permanent improvements, equipment, and livestock.
4. That agricultural advisors be employed.

More than a quarter of a century later, the above recommendations were still not a part of public irrigation authorization and policy. Another investigation and study group was making much the same recommendations as those made in 1924. The President's Water Resources Policy Commission of 1950 wrote, "An adequate

[13] See Marion Clawson, "Planning for a New American Frontier," *Land Policy Review*, November, 1941, pp. 31–36.

program of technical assistance and guidance is needed by settlers, in connection with clearing and leveling land, laying out of the farm irrigation system, and adopting irrigation methods and practices. Advice is needed also in the selection of crops, crop rotations and livestock."[14] It was further stated:

> (1) Congress should provide the necessary funds to assure all settlers on all types of reclamation projects adequate technical training and assistance to foster successful management of the farming operations on irrigation and drainage project lands. This should include provision for adequately staffing the Agricultural Extension Service, for more extensive utilization of the land-grant colleges, all in cooperation with the county agents, the Department of Agriculture, and the Bureau of Reclamation.
>
> (2) Congress should also provide for the sound financing of agricultural development and land settlement on all types of reclamation projects. This should include extension of federal credit at reasonable interest rates for the farmer's investment in structures, equipment, fertilizer, stock, seed, and other requirements, with repayments geared to the farmer's ability to pay under possible changes in circumstances beyond his control. Consideration should be given to the possibility of combining the farmer's obligations in connection with the irrigation project with those involving his investment on the farm so as to furnish settlers with a going concern and a single repayment overhead.[15]

The fact that in the development of present-day irrigation projects the settler has to work most things out for himself is illustrated by the following statement regarding the Columbia Basin:

> The settler must provide shelter for his family, clear the sagebrush from his land, level it, install various kinds of farm irrigation structures, lay out the ditches, build fences, and build livestock shelters. At the same time, he must carry on many farm tasks. Unless he has a large amount of capital to invest, he will need several years to bring all his land under cultivation. On the average it is assumed that only half the irrigable land on each farm will be irrigated the first year of settlement. Substantially all the land on a farm should be under irrigation by the fifth year.[16]

[14] President's Water Resources Policy Commission, Report of, Vol. I: *A Water Policy for the American People* (Washington, D.C.: Government Printing Office, 1950), p. 168.

[15] *Ibid.*, p. 174.

[16] U.S. Department of the Interior, Bureau of Reclamation, *Columbia Basin Project: Opportunities, Responsibilities, and Needs in Irrigation Development*, Development Report 2, February, 1949, p. 9.

It should be obvious that a settler's prospects for success in his endeavor on a new irrigation project are greatly reduced if he must work with an incomplete unit for several years. The situation may be compared with that of an individual who expects to operate a department store but does not have sufficient capital at the beginning to organize the entire business. He doesn't buy or rent a building of the size he expects to need when his business is fully established and then operate a grocery or shoe store in one corner. That would mean paying taxes and other overhead costs on resources he was not yet in a position to utilize. Instead, he secures building space adequate for his needs as he goes through the steps of building toward his goal of a department store. The settler on a new irrigated farm, on the other hand, has no other choice than to pay such overhead costs as taxes and water charges on the entire land area of the farm even though he may be able to utilize only a fraction of it. There is no possibility for the settler to add to the land area as he is ready to utilize it; he must secure approximately the total acreage allowed in the original subdivision of the lands. The best he can do is to bring the total area of the farm into full production as quickly as possible. Stewart has given this description of the situation:

> The difficulty encountered by settlers on irrigation projects in obtaining adequate resources is well-known. Considerable study has been made over the years, especially since 1924 when the Fact-Finders' Committee was set up to investigate the problem. In most cases, these studies showed that the lack of capital was one of the major factors contributing to unsuccessful settlement. In part this situation was due to the encouragement of settlement by those who could not find employment elsewhere and who had virtually no beginning resources except their labor and management. Farmers who had sufficient capital to develop a farm, usually purchased an interest in a farm that was already developed.[17]

Stewart goes on to pose the problem of successful irrigation development in this question: "How can the settler obtain control of and utilize sufficient resources to most successfully develop irrigated farms and areas?" [18] Two possible means of aiding the settler to

[17] Clyde E. Stewart, "Successful Irrigated Farm Development—A Problem in Control and Use of Resources," *Proceedings of the Western Farm Economics Association*, Pullman, Wash., and Moscow, Idaho, June 28–30, 1950, pp. 108–17.

[18] *Ibid.*

secure adequate resources to work with are (1) extend the direct public construction and development beyond the building of a project to deliver water to the high point on each farm and (2) provide adequate and adapted credit so the settler can finance the improvements necessary to get the farm into full production. These two courses of public action will be considered from the standpoint of both state and federal experience in predevelopment.

The Durham-Delhi Experience [19]

In 1917, the State of California initiated a land-settlement program designed to improve on private experience and to encourage further development. This action had been preceded by the work of the California Commission on Land Colonization and Rural Credits which was established by the legislature in 1915. Studies made by the Commission resulted in three major conclusions: (1) a large proportion of settlers in California had failed, (2) more liberal credit was needed than that provided by the Federal Farm Loan Act, and (3) technical services from the colleges of Agriculture and other government agencies should be available to the settlers. More specifically, the Commission suggested with respect to the credit problem that there should be longer periods of repayment with no payment during the first two years and that loans should be made on a larger percentage of appraised value—up to 95 per cent for land.

The California State Land Settlement Board was created to administer the program authorized in 1917. Important aims of the Board included: (1) increasing the number of people on farms and improving their living conditions, (2) improving community life through social organization and cooperative action, (3) selection of settlers with great care, and (4) the employment of a farm advisor as authorized by the legislative act establishing the board. Dr. Elwood Mead, Chairman of the California Commission on Colonization and Rural Credits and later Commissioner of the U.S. Bureau of Reclamation, became Chairman of the Board.

The Land Settlement Board organized two settlement projects: the Durham settlement of about 130 units and the Delhi settlement

[19] Except where otherwise noted, this section is based on Roy J. Smith, "The California State Land Settlements at Durham and Delhi," *Hilgardia* (University of California, Berkeley), XV, No. 5 (October, 1943).

of about 230 units. The Durham settlement, as laid out, included farms of from 20 to 80 acres plus twenty-six farm-laborer allotments of from .4 to 2.4 acres. Delhi farms averaged 28 acres in size and the settlement included sixty-six farm-laborer allotments and fifty poultry allotments of from 3 to 13 acres. Both settlements are on irrigated land. The Delhi project was particularly costly because it involved a concrete pipe distribution system for irrigation water and expensive land leveling.

The Durham settlement, which was undertaken first, showed early signs of prosperity and prompted organization of the Delhi project. The initial indications of success caused the land settlement program to be viewed as a desirable permanent state activity. Following the 1920 break in farm prices, however, settlers of both projects were involved in financial difficulties. Dr. Mead, Chairman of the Land Settlement Board, recommended a strict policy of foreclosure on the delinquent settlers, but this course of action was not permitted by the California governor. The group nature of the two settlements facilitated political pressure against the state and particularly agitation for more favorable terms. In 1925, the California legislature acted to relieve the situation at Delhi when it wrote off $350,000 of the amount owed by the settlers to the state. The Land Settlement Board was abolished by the legislature in 1931 following other relief measures for both Durham and Delhi. Total loss to the State of California on the land settlement program was shown to be about $2,500,000 by the final financial statements; this amount did not include the legislative write-off of $350,000 in 1925.

The Durham and Delhi land settlements are generally classed as having been unsuccessful, and much interest has been expressed in the causes of failure. Smith concludes that the failure of the high-income crops on which the projects were based and the 1920 price break just after the settlements were instituted were major factors in the lack of success. Much of the land selected for the settlements was not of good quality but it was as good as any available for settlement in California at the time. The settlers were judged to have been of average ability and the supply of credit to have been adequate. Smith concludes further that the government control and the administrative organization were not factors in the failure of the projects.

Poli questions whether the fact that the State of California lost considerable money in the Durham and Delhi projects is a sufficient basis for the judgment that the land settlement venture was a failure.[20] It is pointed out that the two settlements have developed into farm communities as successful economically as others in the same general area. The average loss to the state of $69 per acre at Durham is probably about the same as the loss experienced by private landholders during the decline in land values following World War I. The much greater loss at Delhi is attributed to (1) poorer land, (2) higher development costs, (3) less experienced settlers, (4) crop pests and diseases, (5) the later settlement period, which occurred after the postwar decline in farm prices, and (6) the smaller farm units.

Federal Predevelopment Experience

It has been noted that the development of farms on new irrigation projects before they are settled (predevelopment) is not a part of federal irrigation policy, generally. There are, however, examples of predevelopment through public effort which provide valuable information regarding the potentialities of such a policy. Governmental programs of predevelopment in connection with new irrigation have been carried on or sponsored by the U.S. Department of Agriculture whereas the carrying out of the provisions of the Reclamation Act itself is a responsibility of the U.S. Department of the Interior. The Resettlement Administration of the U.S. Department of Agriculture [21] purchased a number of undeveloped tracts of land in 1936 and 1937 on the Milk River and Sun River Reclamation Projects in Montana. Predevelopment work carried on included land leveling and construction of dwellings and farm buildings. The completed units were leased to selected operators and later were sold.

The next step came in 1938 when the Farm Security Administration encouraged the Montana Rural Rehabilitation Corporation to construct the Kinsey Flats Irrigation Project near Miles City and the North Dakota Rural Rehabilitation Corporation to construct

[20] Adon Poli, "What Has Happened to Durham and Delhi?" *The Journal of Land and Public Utility Economics*, XXII, No. 2 (May, 1946), 182–90.

[21] The Resettlement Administration became the Farm Security Administration in late 1937.

the Lewis and Clark Irrigation Project near Williston. On both projects, most of the acreage was acquired by the corporation, leveled, and subdivided into family farms. Dwellings and farm buildings were constructed on the Kinsey Flats Project.

In 1939 and 1940, Congress passed a series of acts which established the "water conservation and utilization projects in the Great Plains and arid and semi-arid areas of the United States." [22] The original act in the series was known as the Wheeler-Case Act, its authors being Senator Burton K. Wheeler of Montana and Representative Francis Case of South Dakota. The projects developed under this legislation are often referred to as "Wheeler-Case Projects." For the sake of brevity, they have been called WCU projects and will be so referred to in this discussion.

The WCU legislation authorized the Bureau of Reclamation to construct irrigation facilities and the Department of Agriculture to acquire land, prepare it for irrigation, and subdivide the area into family farms. All of the lands which passed into federal ownership were leveled with government-owned equipment. Only a few of the farm units on the several WCU projects were provided with dwellings and farm buildings. The start of World War II came at the time when this stage of predevelopment work had been reached on several projects. The necessity of diverting funds and materials to essential defense and war purposes virtually ended the predevelopment.

Three research studies were completed during 1951 which provide an appraisal of the success of three WCU projects as well as the projects developed by the Montana and North Dakota Rural Rehabilitation Corporations.[23] In addition, it was possible to compare the WCU projects with the Vale-Owyhee Project in Oregon which was developed under the most favorable circumstances of any regular reclamation project. That is, settlers on the Vale-Owyhee Project were mostly experienced irrigation farmers, they

[22] U.S. Department of the Interior, Bureau of Reclamation, *Federal Reclamation Laws Annotated* (Washington, D.C.: Government Printing Office, 1947), pp. 653–61.

[23] Kris Kristjanson, *Development of Irrigated Farms on the Mirage Flats Project*, South Dakota Agricultural Experiment Station Bulletin 410, June, 1951; Stanley W. Voelker, *Settlers' Progress on Two North Dakota Irrigation Projects*, North Dakota Agricultural Experiment Station Bulletin 369, June, 1951; Clyde E. Stewart and D. C. Myrick, *Control and Use of Resources in the Development of Irrigated Farms*, Montana Agricultural Experiment Station Bulletin 476, October, 1951.

were provided with considerable practical and technical information, and they received more than the usual financial assistance. The comparison of the WCU projects with the Vale-Owyhee Project was possible because of two studies made in 1938 and 1944.[24]

Comparison of the first ten years of settlement on the Buffalo Rapids Project, a WCU development, and the first ten years of settlement on the Vale-Owyhee Project shows a more rapid development on the former. This is illustrated in Table 2.

TABLE 2

Selected Data for Buffalo Rapids Project, Division 1, Montana and Vale-Owyhee Project, Oregon, During the First Ten Years of Settlement [a]

Year	Farms [b]		Irrigated Acres per Farm		Livestock per Farm		Proportion of Irrigable Acres Irrigated	
	BR	VO	BR	VO	BR	VO	BR	VO
	Pct.	*Pct.*	*Acres*	*Acres*	*A.U.*	*A.U.*	*Pct.*	*Pct.*
1	30	22	68	41			18	13
2	47	31	80	47	21	18	34	21
3	86	57	79	49	23	16	61	40
4	85	77	90	55	29	13	69	61
5	104	88	87	56	23	15	82	71
6	97	94	96	57	31	16	84	78
7	106	94	100	60	21	19	95	80
8	99	97	106	62	19	21	94	86
9	104	99	101	64	32	24	95	90
10	100	100	105	64	27	22	94	92

[a] 1935–44 for Vale-Owyhee and 1940–49 for Buffalo Rapids.
[b] Per cent of year 10.

Source: Stewart and Myrick, *op. cit.*, p. 43.

It will be noted that the land was brought into production more rapidly during the first part of the ten-year period on the predeveloped project (Buffalo Rapids) and that the livestock enterprise was

[24] W. U. Fuhriman, *Settlers' Progress, Vale-Owyhee Project, Oregon,* U.S. Department of Agriculture, Bureau of Agricultural Economics, Berkeley, Calif., April, 1946; Carl P. Heisig and Marion Clawson, *New Farms on New Land,* U.S. Department of Agriculture, Bureau of Agricultural Economics, Washington, D.C., January, 1941.

built up more quickly than on the Vale-Owyhee Project during the same ten-year period. The predeveloped farms also expanded intensive crop production, as represented by intertilled crops, at an earlier date. This is shown in Table 3.

Further evidence of the effect of predevelopment, with particular reference to the availability of buildings, is shown for three projects in Table 4. It will be noted that farm units which were predeveloped to the extent of having buildings realized a significantly larger annual gain in net worth on all three projects.

It is apparent that predevelopment of irrigated farms has reduced the troublesome lag in getting lands into production as well as

TABLE 3

CROPPING PATTERNS DURING FIRST TEN YEARS OF SETTLEMENT ON THE BUFFALO RAPIDS PROJECT, DIVISION 1, MONTANA AND VALE-OWYHEE, OREGON [a]

Year	Intertilled Crops [b]		Small Grains		Hay		Pasture	
	BR	VO	BR	VO	BR	VO	BR	VO
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
1	27	11	66	23	6	60	1	5
2	32	10	57	34	5	48	0	6
3	35	17	56	32	5	35	0	9
4	44	17	36	32	14	36	1	6
5	33	15	48	21	13	46	1	8
6	41	19	40	25	15	40	1	8
7	35	19	39	27	15	41	1	10
8	30	22	43	23	16	38	1	13
9	28	20	40	22	22	39	1	15
10	28	21	40	21	22	38	2	17

[a] 1935–44 for Vale-Owyhee and 1940–49 for Buffalo Rapids. Fallow and soil improvement crops are not included in the percentages of total crop acres.
[b] Sugar beets, corn, and vegetables.

Source: Stewart and Myrick, *op. cit.*, p. 44.

resulting in a more rapid gain in net worth by the settler. What do the settlers who have been operating on predeveloped farms think of the WCU experiment? Many of the operators found much to criticize regarding the government land leveling and layout of the farm irrigation system. Moreover, they were virtually unanimous

TABLE 4

LENGTH OF SETTLEMENT, ANNUAL NET WORTH GAIN SINCE SETTLEMENT, AND IRRIGATED LAND PER FARM FOR SELECTED DEVELOPMENT CLASSES, THREE AREAS, MISSOURI RIVER BASIN, 1950

Item	Length of Settlement	Net Worth Gain per Year	Irrigable Land
	Years	*Dollars*	*Acres*
Government developed farms, sold with buildings			
Buffalo Rapids (Montana) . . .	7.4	1,257	140
Kinsey Flats (Montana)	7.6	1,167	99
Mirage Flats (Nebraska)	2.5	1,320	104
Government developed farms, sold without buildings			
Buffalo Rapids (Montana) . . .	4.1	901	121
Mirage Flats (Nebraska)	2.0	1,043	96

Source: Stewart and Myrick, *op. cit.*, p. 77.

in criticizing the dwellings and farm buildings which had been provided. The operators approved of much of the program of predevelopment, however, as is shown in Table 5. Operators on the Nebraska and Montana projects agreed fairly well with the views expressed by the North Dakota settlers.

TABLE 5

PREFERENCE OF OPERATORS ON BUFORD-TRENTON AND LEWIS & CLARK PROJECTS AS TO WHO SHOULD DO LAND DEVELOPMENT WORK, A FEDERAL AGENCY OR THE LANDOWNER

Type of Development	A Federal Agency	The Landowner	No Reply
	Per Cent	*Per Cent*	*Per Cent*
Heavy Land Leveling	71	23	6
Light Land Leveling	50	44	6
Design and Construction of Dwelling	25	52	23
Design and Construction of Other Buildings	25	52	23
Design of Field Irrigation System . . .	63	27	10
Layout of Field Irrigation System . . .	61	29	10
Driving Well	31	31	38

Source: Voelker, *op. cit.*, p. 54.

Another significant comparison is that between the predeveloped Buffalo Rapids Project and the Lower Yellowstone Project nearby with respect to the proportion of irrigable acreage having water available which was actually cropped in 1944. The Lower Yellowstone Project, developed under regular reclamation law, was cropping approximately 80 per cent of the acreage for which water was available at the end of thirty-five years of development. By comparison, the Buffalo Rapids Project was cropping almost 90 per cent of the irrigable acreage for which water was available after only five years of development.[25]

How Much Predevelopment?

For more than a quarter of a century every individual and group to make an objective study of the problems of irrigation development has recommended predevelopment of new irrigated farms as a tool for solving many of those problems. The experience as shown by the research studies cited above indicates that, where predevelopment has been tried, it has produced definite and measurable benefits. There is not, however, general agreement on how far the public should go in a program of predevelopment.

There are three possible levels of governmental action in irrigation development. First, there is the possibility of total predevelopment including land leveling, building construction, drilling of a well, and, perhaps, fencing. Proponents of carrying predevelopment to the limit argue that if a settler can take over a fully developed unit, his chances for success are enhanced because he can devote full time to the business of farming and not find it necessary to take time to construct buildings and carry on other improvement work.

Second, there is the possibility of no predevelopment work—basically, the policy of public irrigation development for the past fifty years. Advocates of the traditional policy of letting the settler solve his own problems usually argue that a program of predevelopment is socialistic and will destroy the moral fiber of the farm families. Just why the line between socialism and acceptable public

[25] Ivan D. Wood, "Experience in Converting Land to Irrigation Use," *Proceedings of the Northern Great Plains Agricultural Advisory Council*, Custer, S.D., August 7–9, 1945, pp. 72–80.

action should be drawn between public construction of an irrigation system and land leveling by a government agency is not clear.

Third, there is the possibility that certain phases of farm development be carried on by a government agency as a program of predevelopment while the remainder of the farm development is left to the settler. Land leveling is an obvious phase of farm development to be carried on as a part of the public effort for several reasons: (1) heavy leveling requires engineering knowledge which the settler does not possess; (2) heavy leveling requires large-scale dirt moving equipment which is beyond the resources of the individual; (3) the cost of land leveling could be included in the repayment contract for the irrigation system itself, thus simplifying the operators' financial problems; and (4) a substantial majority of the settlers who have had experience with government land leveling are in favor of it.

Design and construction of the farm irrigation layout might well be a part of predevelopment by a government agency for much the same reasons. It is with respect to buildings that most operators are opposed to predevelopment. Settlers will all have different ideas regarding what they want incorporated into a dwelling and other farm buildings. Then, too, most settlers feel that they can do much of the construction work and save a considerable amount of money. Fencing is another phase of farm development which might well utilize family time and talent. Whether or not the drilling of a well should be a part of public predevelopment might be determined by how deep it is necessary to go for water and the expense involved.

The possibility of land leveling being carried on by private contractors, or by group action of the settlers, cannot be ruled out. The availability of capital is a major factor in such an alternative. The writer is reminded of a situation observed during the summer of 1948. A group of war-veteran settlers on new farms on a federal reclamation project in Wyoming had hired a contractor to level all their land. An excellent job of land leveling had been done and there was a fine crop on the land. The settlers had spent all their available money for land leveling, however, and were unable to put down wells, build adequate dwellings and other buildings, or fence their farms. They were poorly housed and were hauling water in cans from the nearby town for household use. None of the settlers had a "going concern" and particularly noticeable was the lack of

livestock which was associated with the building-fencing-water situation.

Another means of carrying on irrigation farm development is through Soil Conservation Districts. If newly irrigated lands are included in a district, farm operators may have access to heavy land-leveling equipment and technical assistance. These are the two biggest needs of the settler working alone. Some areas have found Soil Conservation Districts of considerable value in the development of new farms on irrigated lands.

Demonstration Farms

Another aid to successful settlement and development of new farms is the establishment of demonstration or predevelopment farms. These are farms operated by one or more public agencies in advance of and during the period of settlement. Investigations and demonstrations are carried on with respect to adapted crops, crop rotation, fertility requirements, irrigation practices, control of insects and diseases, and control of salinity.

The Tennessee Valley Authority has used the demonstration farm technique as the core of the program of better farming in the Valley. In the Tennessee Valley, the demonstrations are a part of the operations on 20,000 of the privately owned farms in the region. Lilienthal wrote:

> These thousands of typical working farms are the schoolrooms of the valley. Here farmers, their wives and children, with their neighbors learn and demonstrate the unity of resources, learn and demonstrate the principles of grass-roots democracy. Here there is brought to them the fruits of the technical man's skills. . . .[26]

The TVA experience with demonstration farms has been the model for similar programs elsewhere in the United States and in many foreign lands. The carrying on of demonstration farming on privately owned operating units is, of course, the ideal approach where the pattern of agriculture is established and the problems already exist and are known. The value of the demonstration farm technique in new irrigation developments lies in determining what problems are likely to arise and in finding solutions for those prob-

[26] David E. Lilienthal, TVA, *Democracy on the March* (New York: Harper & Bros., 1944), pp. 79–80.

lems in advance of settlement. Hence the program of establishing demonstration or predevelopment farms to be operated by public agencies in advance of project settlement. The program for the Columbia Basin has been described as follows:

> To bring water to the predevelopment farms, wells will be used until water from the irrigation works becomes available. The Bureau of Reclamation will operate the units and a part of each unit will be set aside for the experimental programs of the other agencies. In this way, the units will serve as demonstration farms for the settlers while permitting investigations in the field. It is planned to continue the experimental farms in operation through the first few years after settlers arrive to help them during their adjustment period. As new areas are scheduled for irrigation, other predevelopment farms will be established.[27]

Adequate and Adapted Credit

The second means of aiding the settler to secure control of sufficient resources in the early stages of settlement, in addition to predevelopment activities by public agencies, is through programs of providing adequate and adapted credit. The lack of credit has long been cited by students of irrigation problems as the biggest stumbling block to successful farm development. The difficulties experienced by settlers in securing necessary financing have been described in research studies.[28]

The problem of financing the irrigation farmer is the dual one of providing enough credit and of making available the right kind of credit—a type of credit adapted to the peculiar characteristics of new irrigated farms. The following excerpt illustrates the need:

> Present lending institutions cannot be expected to supply in adequate amounts and on suitable terms the credit needs of settlers. Private financial concerns are not generally interested in making development loans. Development credit is largely outside their field of experience and risks are difficult to appraise. The state has no agency or funds for making loans for farm development purposes. Of the federal lending agencies, only the Farmers' Home Administration is presently authorized to make such loans. Funds currently available to

[27] H. P. Singleton, "Predevelopment Paves the Way," *Reclamation Era*, XXXIII, No. 3 (March, 1947).

[28] See Dorothy Lampen, *Economic and Social Aspects of Federal Reclamation* (Baltimore: The Johns Hopkins Press, 1930), pp. 76–90.

> this agency, however, are altogether inadequate to meet future credit needs of settlers on the Columbia Basin Project.
>
> Short term loans from commercial banks are not suitable development credit because several years ordinarily are required to bring an irrigated farm into full production. There is no surplus for debt retirement during these early years because capital expenditures exceed income. Farmers, failing to fully recognize this fact, frequently run out of funds when farm development is far from complete. Similar lack of understanding by lending agencies leads to inadequate financing and unsound arrangement covering repayment of loans.[29]

A recent study of capital requirements and credit experience among settlers on newly irrigated lands revealed some significant facts. Operators of larger farms, farms with higher productivity ratings, farms with longer periods in development, and farms with larger outside capital inputs were able to fill a large part of their credit needs at commercial banks and to secure longer-term loans at lower rates of interest than were the reverse types of farms. Smaller farms, farms with lower productivity, and farms with smaller outside capital inputs were dependent primarily on short-term loans at higher rates of interest from private individuals.[30]

It is likely that, unless commercial lenders are able to offer credit adapted to the needs of settlers on new irrigated farms, the sources of public financing will have to be expanded to meet the need. Such an expansion of governmental credit facilities would have a precedent in past governmental action to establish credit sources adapted to the peculiar requirements of agriculture. Once the new lending methods and techniques have been proven, it has been common practice for the private lenders to pattern their operations after the governmental lending agency. The crux of the problem in filling the credit needs of settlers on undeveloped irrigated lands lies in the fact that they need loans based on the expected productivity of the farm in the future and not based on current equity of the operator. This is, of course, quite different from the accepted standards of private lending, but nothing less

[29] *Columbia Basin Project: Opportunities, Responsibilities and Needs in Irrigation Development, op. cit.*, p. 32.

[30] Marlowe M. Taylor, *A Study of Capital Requirements and Credit Experience on Newly Developed Irrigation Lands, Roza Division, Washington*, A thesis for the degree of Masters of Arts in Agricultural Economics, the State College of Washington, 1949. (Reproduced by the U.S. Department of the Interior, Bureau of Reclamation, Boise, Idaho.)

will fill the credit needs of the people who undertake to develop new irrigated farms on raw land.

The problem of providing adequate and adapted credit will become more critical as more of the lands in irrigation projects now under construction or proposed for development reach the settlement stage. Some indication of the size of the problem is contained in Table 6. The settler needs capital assets of $5,175 if he begins with the minimum of an undeveloped farm and used farm machinery. At the other extreme, capital assets of $37,500 are needed for full equity in a well-developed farm. Most potential settlers are likely to have capital assets approximating $5,000, leaving more than $32,000 to be secured before a farm is well developed.

TABLE 6

ASSETS THE SETTLER MUST HAVE TO BEGIN OPERATIONS ON IRRIGATED FARM WITH FULL EQUITY IN MACHINERY AND LIVESTOCK, WITH LAND LEASED OR PURCHASED, WITH AND WITHOUT IMPROVEMENTS, SYNTHETIC FARM SITUATIONS, BUFFALO RAPIDS, MONTANA, 1950 [a]

Item	Well-Developed Farm	Undeveloped Farm
	Dollars	*Dollars*
Full equity	37,500	18,800
Land bought without improvements [b]	29,900	11,200
Land bought with improvements [b]	22,775	9,775
Land leased without improvements	———	10,800
Land leased with improvements	22,000	9,000
Land leased with improvements—all machinery bought used [c]	14,575	5,175

[a] If buildings and other improvements are put on the farm before it is sold or leased to the operator it is assumed that these would be of permanent type and adequate after full development. In the case of land bought without improvements, the operator must finance a complete set of buildings for the well-developed farm and the barest minimum set for the undeveloped farm.

[b] Operator makes 5 per cent down payment of cost of land and improvements already there.

[c] Machinery is depreciated to 55 per cent of early 1950 price.

Source: Stewart and Myrick, *op. cit.*, p. 71.

Subdividing Projects into Farm Units

The ownership pattern of lands in the western states has been established by the rectangular system of survey and land description. The rectangular farm of 40, 80, or 160 acres is not well adapted to

irrigation unless the land lies on a regular, uniform slope. A more efficient method for subdividing lands into irrigated farms is to take into account topography and such man-made features as canals, drainage ditches, and highways. Reclamation law authorized irregular subdivision in 1906 if it was necessary in order to provide for practicable and economical irrigation.[31] Some of the difficulties associated with the rectangular survey have been solved by a gradual process of land purchase, sale, and exchange among owners who realized the advantages of farm boundaries based on topography.[32]

Those lands which were acquired by the U.S. Department of Agriculture on WCU projects for purposes of leveling the land were subdivided into farms on the basis of topography and other features. Wallinder points out that a soils survey, land classification, and a topographic survey are prerequisite to such a system of subdivision. In addition, the following features were considered when establishing farm and field boundaries: (1) railroads, (2) highways, (3) natural water courses and surface drains, (4) main project laterals that follow topographical features, (5) project roads which are located on drainage courses and parallel to laterals and canals, and (6) proposed direction of irrigation after development.[33]

Irrigated farms established on the irregular pattern result in a lower original investment cost for certain construction features and in lower farm-operation costs once the farm is organized. Properly designed, a project developed on the basis of irregular subdivision will have fewer miles of roads, fewer power and telephone lines, fewer expensive flumes and siphons, and fewer bridges across canals and drainage ways. On the farms themselves, such development will mean only one headgate per farm, the elimination of small tracts isolated from the balance of the farm acreage, and the elimination of short runs in the application of irrigation water. The fact that the farm is in one compact body of land and that the fields have been shaped to facilitate the application of irrigation water results in efficiency in operation, which will mean reductions in operating costs year after year.

The elimination of the rectangular system of survey and the subdivision of irrigation projects on the basis of topography would

[31] *Federal Reclamation Laws Annotated, op. cit.*, p. 100.

[32] W. W. Johnston, "Topography and Irrigation Farming," *Reclamation Era*, XXXIV, No. 4 (April, 1948).

[33] W. O. Wallinder, "Farm Layout," *Proceedings of the Northern Great Plains Agricultural Advisory Council*, Custer, S.D., August 7–9, 1945, pp. 81–85.

have been relatively easy of accomplishment while irrigation projects were being constructed on the public domain. In those instances where federally owned lands are included in present-day irrigation development, irregular subdivision would be feasible. Obviously, however, with most irrigation development now involving privately owned lands, such a program is virtually impossible without public acquisition of lands as in the case of the WCU projects. At the present time, public opinion is largely opposed to further acquisition of lands by the federal government. But such acquisition should be viewed from the standpoint of its value as an intermediate step in the orderly development of new irrigated lands. If it were presented as a tool in the development process toward individually owned irrigated farms, the problem might be solved without difficulty.

Providing Technical Assistance

It will be recalled that a consistent and persistent recommendation for expanded public action throughout the fifty-year history of the Reclamation Act has been concerned with technical assistance for the settlers. Various methods have been used to meet the need. The Bureau of Reclamation has cooperated with the Agricultural Extension Services of the various states in the employment of assistant county agents to be stationed on reclamation projects and work with the irrigation farmers. On the WCU projects, the U.S. Department of Agriculture provided farm management specialists who helped the new settlers to work out many of their problems.

In those areas where new irrigated lands are being developed, the personnel and facilities of the Agricultural Extension Service should be expanded to provide adequate professional assistance. Substantial increases in personnel will be required in those areas where large acreages are to be irrigated.

Water as a Factor of Production

The production process, whether it be in industry or agriculture, is commonly considered to utilize four factors—land, labor, capital, and management. The economic definition of land is taken to include all "the gifts of nature"—the land itself, water, air, light, and

heat. Water is regarded as an attribute of the land factor which will remain relatively unchanged as supplied by nature.

In the case of irrigation farming, water takes on many of the characteristics of a factor of production in its own right and can be considered as separate and distinct from land. The improvements to the land necessary to provide the physical means of bringing water to the agricultural enterprises involve outlays of capital, often in large amounts. The problem of drawing the line between the land factor and certain parts of the capital factor (ditches, laterals, structures, etc.) may be difficult. However, the following characteristics point to water on irrigated farms as a fifth factor of production:

1. Water is scarce—this is one of its most important characteristics.
2. There are property rights in water, i.e., the right to the use of water is owned.
3. Irrigation water is an important cost item in farm production and one that takes its place apart from other cost items.
4. Water is the subject of many economic, legal, and social institutions which have grown up distinct from those concerning land.
5. Irrigation water requires technical knowledge concerning methods of application, quantities used, and effects on production, which sets it apart from the other factors of production in the eyes of management.

Management of Water

The management of water, then, is an important phase in the success or failure of production on irrigated farms. There is much evidence that excessive use of water is far too common on irrigated farms. It can only result in a gradual deterioration of the land. The use of more water than the crops require may be a result of (1) lack of knowledge regarding water requirements of various kinds of crops, (2) failure to use the best method of irrigation for the type of soil and the topography involved, and (3) general inexperience on the part of the irrigation farmer. The remedy for these deficiencies in the management of water can be found in providing more and better technical advice and assistance to irrigation farmers.

Problems of water management complicate the larger task of over-all farm management. The same degree of diversification presents a greater challenge to good farm management on an irrigated

farm than on a similarly organized nonirrigated farm. The water factor may compete for the available capital and will certainly do so in the case of the labor supply. Competition for seasonal labor is unusually intense on irrigated farms because labor is needed not only to fill the ordinary jobs of the cropping season but to apply water.

It is evident, then, that an irrigation farmer must possess the necessary technical skills as well as superior managerial ability if he is to provide efficient management of the water factor in his operations.

Conservation of Irrigated Land

The development of irrigated lands is viewed by many people as a conservation process. The combination of resources resulting from this conservation effort, however, provides the basis for serious conservation problems on the lands thus made usable for intensive agriculture. Criddle wrote, "It is ironical that the life-giving water brought to arid lands can also be the means of destroying them. Many serious land and water problems confronting irrigated agriculture today are a result of man's misuse of these resources." [34]

A study of three irrigated areas in Montana found that six factors contributed to soil and fertility depletion. They were (1) erosion from poor use of irrigation water, (2) leaching and seepage, (3) failure to maintain a balance between soil-depleting and soil-conserving crops, (4) a deficiency in livestock numbers, (5) failure to use commercial fertilizer where needed, and (6) the encroachment of weeds upon farm land.[35]

It has also been pointed out that conservation problems may arise during the earliest stages of development. Farmers on the Vale-Owyhee Project found that land leveling exposed the soil to wind and water erosion before the land could be brought into production.[36]

[34] Wayne D. Criddle, "Improving Farm Irrigation Practices," *Journal of Soil and Water Conservation*, V, No. 1 (January, 1950), 18–22.

[35] P. L. Slagsvold and H. H. Lord, *The Conservation of Montana's Irrigated Lands*, Montana Agricultural Experiment Station Bulletin 350, December, 1937, p. 29.

[36] U.S. Department of Agriculture, Bureau of Reclamation, *Farm Experience Studies* (Columbia Basin Joint Investigations) (Washington, D.C.: Government Printing Office, 1942), p. 81.

Farm operators on irrigated land are faced with the same problems of conservation as other farmers. In addition, they must contend with the peculiar problems generated by the application of irrigation water to the land. The problem of conserving existing irrigated land has received too little attention. Most of the emphasis has been on irrigating new lands.

CHAPTER 9

Integrated Use of Irrigated Land

Irrigation water may benefit agriculture through (1) increased production and (2) increased stability. In the past, emphasis has been largely on increased production. Only in recent years has much attention been given to the value of irrigation in stabilizing the agriculture of an area.

The word "integrate" may be defined as *to bring together parts of a whole as a means of achieving a more simple and stable situation.* Land use in the West, when considered as a process of integration, means that irrigated land and dryland are parts of the whole. As the different types of land were developed and used separately, the result in many areas of the West has been a complex and unstable situation. In contrast, many areas have achieved a more stable economy through the integrated use of irrigated lands and dry lands.

Another expression is sometimes used to describe the integrated use of land in the West. Starch suggested that, "Diversification by areas, however, as over against diversification by specific farm units may be a concept which will apply under semi-arid conditions." [1] The term "area diversification" emphasizes the importance of integration in contrast to the customary type of diversification which is limited or impossible on many farm units in the semiarid regions.

John Wesley Powell, Prophet

The inseparability of irrigated land and the surrounding area was recognized at an early date by Major John Wesley Powell, Director of the U.S. Geological Survey. History is full of examples of individuals who seemed to possess the uncanny ability of outlining a course of action for the future which later events proved to be em-

[1] E. A. Starch, "Type of Farming Modifications Needed in the Great Plains," *Journal of Farm Economics,* XXI, No. 1 (February, 1939), 144–20.

barrassingly prophetic. Major Powell's blueprint for western agriculture was contained in his "Report on the Lands of the Arid Regions of the United States," published in 1879. His forecast of the problems that would develop in carrying agriculture beyond the humid regions of the United States was amazingly accurate. Students, teachers, and makers of agricultural policy have turned in increasing number to a study of his recommendations for a land-use and settlement pattern in the arid and semiarid West.[2]

Major Powell recognized three great land uses in the semiarid West: (1) irrigable lands, (2) timbered lands, and (3) pasturage lands. His conception of irrigable land was limited to stream bottoms; he did not envision the watering of large acreages of high benchlands included in many irrigation projects today. His classification of timbered lands included the highland areas which were natural timber producers. The pasturage lands were to utilize all the rest of the acreage. He did not include dryland farming in his program for a land policy in the West. It was obvious to him that it would be impossible to develop agriculture in the semiarid West on the same pattern as in the humid regions of the United States. Major Powell emphasized the great risk and extreme variability of crop production in the "twilight zone" between the subhumid and the semiarid regions. It was impossible to foresee development of the drought-resistant plant varieties, moisture-conserving farming practices, and large-scale machinery which makes successful nonirrigated farming in the semiarid regions possible.

Major Powell's recommendations for a settlement policy in the West included several revolutionary ideas. He suggested the minimum size of a ranch as four sections or 2,560 acres. He had seen how the available water would be monopolized by homesteading the strategic quarter-sections. This led him to recommend a change from the square blocks, of the rectangular system of survey, to a system of tracts all having frontage on the available water supply for livestock and irrigation. The tracts would be equal in area (2,560 acres) but irregular in shape to take advantage of topography. He recommended that these ranch units be organized into self-governing "pasturage districts" with a minimum of nine mem-

[2] J. W. Powell, *Report on the Lands of the Arid Regions of the United States* (Washington, D.C.: Government Printing Office, 1879). See especially Chap. ii, "The Land System Needed for the Arid Region," pp. 25–45.

bers to each district. He recognized the problems involved in providing and supporting schools, roads, churches, and other community services in a sparsely populated area. He suggested a grouping of the residences of the nine or more members of a "pasturage district" to achieve a better community life. Major Powell's ideas regarding a settlement policy for the West were offered to the Congress of the United States in the form of two suggested bills which he drafted: (1) to authorize the organization of irrigation districts and (2) to authorize the organization of "pasturage districts." The proposals were not enacted into law but many of the basic ideas of the "pasturage districts" were included in the Taylor Grazing Act passed by Congress fifty-five years later.

Major Powell continued to emphasize his ideas when he addressed the North Dakota Constitutional Convention ten years later in 1889. He warned the members of the convention that they must make their settlement pattern and agricultural methods fit the environment they found in the region. He said:

> The State of North Dakota has a curious position geographically in relation to agriculture. The eastern portion of the state has sufficient rainfall for agricultural purposes; the western part has insufficient rainfall, and the western portion is practically wholly dependent on irrigation. In the western portion, all dependence on rains will ultimately bring disaster to the people.[3]

Instability of Semiarid Agriculture

The regions of the world having a semiarid climate experience considerable variation in rainfall. The Great Plains is such a region and it was there that Powell found the basis for his prophetic observations and recommendations. With respect to the unpredictable variability of the climate of the region, Starch observed:

> If the climate were consistently humid as it is in the Mississippi Valley or consistently arid as it is in Arizona an economy could soon be devised that would fit the area. However, we should recognize that a true definition of semi-arid means that half of the years are dry and the other half are wet rather than that there is fifteen inches of rainfall every year as over against thirty inches in humid areas. Furthermore, the wet and dry years do not come in series nor alternately,

[3] J. W. Powell, "Importance of Water Conservation," Address at the North Dakota Constitutional Convention in Bismarck, August 5, 1889.

but are unpredictable in their succession. By such a definition we have described the fundamental characteristics upon which a Great Plains economy must be built.[4]

Much attention has been given to the possibility that the periods of large and small rainfall might occur with some regularity, thus establishing a cyclical pattern which could be predicted. The study of tree rings has been undertaken in a number of places in the western states. By this procedure, the amount of annual growth as shown by tree rings is correlated with annual precipitation as shown by weather records for those years. Trees which antedate the weather records are used to project the historical picture of annual precipitation into the years prior to the keeping of weather records. A report from western Nebraska reads, in part, as follows:

> A study of tree rings in carefully selected specimens of red cedar and ponderosa pine from various parts of western Nebraska shows that for the last 400 years there have been frequent dry years or short periods of dry years with less frequent droughts lasting for 5 years or more. The latter have averaged 12.85 years in length, and the period between them 20.58 years. The correlation between annual ring growth and annual rainfall as recorded by the Weather Bureau indicates a high degree of statistical significance. The data do not show precipitation cycles of sufficient regularity to be of value in the exact forecasting of future droughts.[5]

In another study of tree rings conducted in North Dakota, it is pointed out that the records of tree-ring growth will show less variation from year to year than the actual rainfall since effects of a wet year may carry over to some extent into a succeeding dry year.[6] The author goes on to relate this North Dakota study to irrigation as follows:

> It seems to show that more than half of the years are wet enough to discourage attempts at irrigation. In other words, the region is marginal as far as irrigation is concerned. Previous experience has shown that as a dry period fades out, interest in irrigation fades with it. Conditions are decidedly different from those in the more arid territory further west where irrigation is practically an annual necessity. Therefore, it would seem that, though irrigation would have great definite value to the area, it must be based on a system which

[4] Starch, *op. cit.*

[5] Harry E. Weakly, "A Tree Ring Record of Precipitation in Western Nebraska," *Journal of Forestry*, XLI, No. 11 (November, 1943), 815–17.

[6] Geo. F. Will, *Tree Ring Studies in North Dakota*, North Dakota Agricultural Experiment Station Bulletin 338, April, 1946, p. 19.

will not carry a high overhead in favorable years, and the elements of which may be kept in a sort of dormant state, to be brought into use again as the dry periods return after the wet ones.[7]

Weakly took note of the tendency to consider some of the variations in rainfall as a part of permanent change in climate when he observed:

> It is probable that during some of the protracted droughts of the past the country approached an absolute desert in character; hence the deterioration of native grass cover and the dust storms of the past few years do not indicate a permanent change in climate for this section, but more probably a recurrence of conditions that prevailed before.[8]

A statistical study of annual precipitation in the western United States did not support the popular assertions regarding unusually variable precipitation—extremes of drought or wetness. With respect to the Great Plains, Clawson wrote:

> However, annual precipitation in much of the Great Plains is variable around a critical point—that at which successful wheat production begins. In years drier than average, wheat yields are reduced, perhaps to zero; in years wetter than average, wheat yields are high. Relatively small variations in precipitation around a critical point mean large variations in wheat yields. But it is inaccurate to confuse the significance of such variation in precipitation with the amount of variability.[9]

Clawson pointed out that, although the variations in annual precipitation from year to year are relatively small, large cumulative deficits and excesses of moisture have highly important consequences. When there are series of years with precipitation averaging above the long-term normal and also series of years with precipitation averaging below the normal, false ideas as to the true character of the climate in the area can easily arise. Misconceptions regarding the climate of the Great Plains were common during the early settlement of the region. Discussing the early attempts to farm on the Great Plains, Mead observed:

> The first general attempt of this kind began in 1883. Western Kansas and Nebraska were dotted with farm houses. Eastern Colorado

[7] *Ibid.*, p. 24.

[8] Weakly, *op. cit.*

[9] Marion Clawson, "Sequence in Variation of Annual Precipitation in the Western United States," *Journal of Land and Public Utility Economics*, XXIII, No. 3 (August, 1947), 271–87.

> was largely settled up between 1886 and 1889. A few wet years, in which fine crops were grown, were followed by a succession of dry seasons. On millions of acres crops shriveled and died, men lost hope and energy through repeated bitter failures, and women and children endured dreary years of poverty and hardship. Homes which represented the savings of a lifetime had to be abandoned. Whole counties were almost depopulated. What had been thriving towns were deserted.[10]

The seasonal variations in precipitation within any one year are an important factor in the instability of agriculture in the Great Plains. The fact that variations in annual precipitation are associated with the critical point at which wheat production is feasible explains why even small variations in seasonal precipitation are feared. Indeed, variations in seasonal precipitation may spell the difference between good and poor crops even though in the long run annual precipitation is normal or above normal.

Variations in precipitation are reflected in crop yields and farm income. A North Dakota study showed that, in McLean County, wheat yielded either less than 4.1 or more than 16.9 bushels per acre in one-third of the years. Also, as with precipitation, wheat yields tend to occur in "runs" of several bad or several good years in succession. Thair noted:

> For North Dakota as a whole, during the 70-year period of 1879–1948, there were three separate periods when wheat yields were above average for a run of three or more years and two of these runs lasted nine years each. In four separate periods, yields ran below average for three or more years in a row; one of these was five and another twelve years long. The other periods were of two years or less, including nine years when yields alternated above and below average each year.[11]

The same general situation prevails in the southern Great Plains. The area of Oklahoma west of the ninety-eighth meridian has been called "a chronic drought area." Droughts serious enough to cut crop yields by 50 per cent or more have occurred thirteen times in thirty years.[12]

[10] Elwood Mead, "The Relation of Irrigation to Dry Farming," *Year-book of the U.S. Department of Agriculture, 1905*, pp. 423–38.

[11] Philip J. Thair, *Stabilizing Farm Income Against Crop Yield Fluctuations*, North Dakota Agricultural Experiment Station Bulletin 362, September, 1950, p. 9.

[12] Robert S. Kerr, "Plow, Plant, and Pray," *Reclamation Era*, XXXIV, No. 5 (May, 1948).

In considering the problem of income instability in high-risk farming areas, Heisig suggested that the answer is a system of reserves including (1) accumulation of financial reserves, (2) crop insurance, (3) drought loans, and (4) variable mortgage payments.[13] It is true that, for much of the semiarid West and particularly the dry-farming areas, the solution to the problem of instability will have to be found within existing operating units or units very much like those now in existence. The following is pertinent to this point:

> For example, two farms may be subject to the same degree of yield variability but the business and financial organization of the one may be such that 1 or 2 years of low yields can be regarded merely as a longer-than-average production period. Failure to obtain returns for a few years of production inputs, followed by high returns for a few years, need not be regarded as a cause of unusual risk under such a plan of business organization.[14]

The above are examples of an approach to the problem of instability in semiarid agriculture through the creation of adapted institutional arrangements and farm-management concepts. The problem can be attacked also through improvement in the organization and use of natural resources. The contribution which irrigation development can make is of importance in that connection.

Irrigation and Stability

The major importance of irrigation in many areas of the West lies in promoting stability and flexibility in production rather than in adding to the quantity of goods produced. To some, it may seem contradictory to speak of stability and flexibility in the same breath. It is characteristic of much of the western United States, however, that stability in production will be realized by greater flexibility—an ability to adjust to changing climatic and economic conditions. Starch described it thus:

> The keystone of an economy based on variations would be flexibility. Or to use a catch phrase, it would be an ability to "roll

[13] Carl P. Heisig, "Income Stability in High-Risk Farming Areas," *Journal of Farm Economics*, XXVIII, No. 4 (November, 1946), 961–72.

[14] E. Lloyd Barber and Donald C. Horton, "Measuring and Interpreting Farm Production Risks," *Agricultural Finance Review*, (U.S. Department of Agriculture, Bureau of Agricultural Economics, Washington, D.C.), XI, (November, 1948), 28–38.

> up" and "unroll" much after the manner of some plants and seeds which have structural provision for meeting unfavorable conditions in order that they may later take advantage of suitable growing conditions.[15]

The basic instability of a land use and settlement pattern where one operator had all grassland with no adequate source of winter feed while another had all the river bottom land and no range land was well summarized years ago by a writer who wasn't thinking of the semiarid West. In discussing the utilization of every piece of land to the fullest advantage, he wrote:

> This means a new division and perhaps a redistribution of land in such a way that the farmer will have his due proportion of hill and valley, rather than that one shall have all valley and another all hard scrabble on the hill or all waste land in some remote place. It means that there will be on each holding the proper relation of tilled land and pasture land and forest land. . . . It means that we shall cease the pretense to bring all lands into farming. . . . In the farm region itself, much of the old division will pass away, being uneconomical and nonsocial. The abandonment of farms is in some cases a beginning of the process but it is blind and undirected.[16]

Prior to the drought period of the 1930's, only a few persons talked and wrote about the integrated use of irrigated land. The irrigation program developed for the Great Plains and similar areas as a result of the drought placed great emphasis on the importance of integrated land use in achieving a stable economy. The sudden shift in thinking that took place after the drought was not at all surprising. It did not require acute observation to see that, in many cases, the ranchers who came through the drought in the best condition were those with an operating unit involving the use of irrigated land with grazing land. In other words, the idea of integrated land use has been proven practicable over a period of many years by successful ranchers throughout the West.

The integrated pattern of land use appears to be an important step in the direction of an agricultural economy adapted to semiarid conditions. The bringing in of unadapted culture patterns from the humid areas has plagued the semiarid region since earliest

[15] Starch, *op. cit.*

[16] L. H. Bailey, *The Holy Earth* (New York: Charles Scribner's Sons, 1915), p. 58.

settlement.[17] It has been noted that, "only those who have lived in farming areas which periodically experience total crop failure on the non-irrigated land know what an oasis an irrigation project seems in a year of failure on surrounding land." [18] A Department of Agriculture report suggests, "on the agricultural side, irrigation should be developed to supplement to the greatest possible extent the use of the range and dry-land resources." [19]

How much can irrigation contribute to a stable agriculture in the semiarid region? How can the use of land resources be integrated? What are the limitations to integration? These are the vital questions to be considered in the following sections of this chapter.

Methods of Integration

The extent to which integration may be secured will depend on the method used. There are a number of methods which may have varying possibilities depending on the physical, economic, and social conditions present.[20]

The two most direct types of integration differ mainly in their major emphasis. The *first* type is illustrated by the irrigation farmer who has an acreage of grazing land as part of his operating unit. The grazing land may be owned or leased, or may consist of rights in a grazing district or the forest reserve. The *second* direct type is illustrated by the rancher with headquarters in the range country who has an irrigated feed base. The feed base may be privately developed on a small scale as part of the ranch itself or may be owned or leased on a full-scale irrigation project in the general area. Both of these direct methods of integrated land use are a major factor in developing and maintaining a stable economy.

A *third* type of integration is not so direct and certainly not so easily visualized and understood as the two just discussed. It is the

[17] Carl F. Kraenzel, "New Frontiers of the Great Plains," *Journal of Farm Economics,* XXIV, No. 3 (August, 1942), 571–88.

[18] Sherman E. Johnson, "Irrigation Policies and Programs in the Northern Great Plains Region," *Journal of Farm Economics,* XVIII, No. 3 (August, 1936), 543–55.

[19] U.S. Department of Agriculture, Bureau of Agricultural Economics, "Agricultural Development and Problems of the Missouri Valley," presented before the Senate Committee on Irrigation and Reclamation, September 20, 1945.

[20] Roy E. Huffman, "Stabilizing Farm Economy Through Integrated Use of Irrigated Land," *The Montana Farmer,* January 15, 1947.

stabilizing influence exerted in an area by a body of irrigated land even though the units involving actual combination of irrigated and grazing land may be few or nonexistent. The irrigated area does provide a source of hay to be purchased by operators in the surrounding range area. Feed grains may move both ways, depending on the circumstances. In drought periods, dryland operators may turn to the irrigated areas for feed grains as well as hay. During periods of favorable weather conditions, operators engaged in livestock fattening programs on irrigated farms may find the surrounding dryland areas to be their cheapest and most convenient source of feed grains.

The looseness of this type of integration should be emphasized. The closer the integration can be made between irrigated and grazing land, the less likely it is to get out of balance during periods of drought or above-average precipitation. Operators in dryland areas usually produce sufficient feed on their own units during periods of high precipitation and do not buy feed from the operators on irrigated land. The operators of irrigated land are forced to grow other crops when their market for feed crops disappears. Because of this situation, dryland operators may be unable to buy sufficient feed crops from the irrigated farms to feed their livestock through a drought.

The *fourth* type of integration involves the exchange of livestock between irrigated and dryland areas. The relationship is usually one between the producers of feeder cattle and feeder lambs in the range area and the operators of irrigated farms who are engaged in fattening operations. In some instances, the exchange may be reversed with dryland operators buying livestock from irrigated farms. This method, like the third, is not so readily apparent. The integration is there, however, and it is of great importance in extending the influences and benefits of irrigation into the surrounding area.

Thus far, this discussion has been limited to the integration of irrigated and grazing lands. There is a certain amount of integration in many areas between irrigated lands and dry croplands. This *fifth* method may involve a direct combination of the two in the same operating unit, in which case wheat on dry land may be a cash crop, or small grains for feed grown on the dry land may be a part of the feeding operations on the irrigated land. Or, as pointed out

previously, the integration may be less evident and involve the production of feed grains by a dryland operator for sale to livestock feeders on irrigated land many miles away.

A *sixth* type of integration is concerned with the exchange of farm and ranch labor between irrigated and dryland units. This may be mutually advantageous in that a more stable supply of seasonal labor becomes available for the entire area if employment can be assured for a greater part of the year.

There is a *seventh* possible form of integration which is favored by landowners in connection with some new irrigation developments. It involves the "scattered" irrigation pattern as contrasted to the "solid-block" pattern characteristic of existing projects. This proposed system of irrigation development would include a much larger acreage within the distribution system of the project than there would be water available to irrigate. Only a part of each farm unit would be irrigated and the total acreage which could be irrigated would be determined by the water available. Greater water loss in the larger distribution system might result in less total acres irrigated than could be watered under a smaller distribution system.

Proponents of this seventh type of irrigation pattern point out that it would do the following:

1. Permit selection of lands best adapted to irrigation.
2. Largely eliminate the drainage problem.
3. Spread the stabilizing effects of irrigation development over a larger area.
4. Encourage a highly diversified type of agriculture.

Principal objections raised by engineers concern the increased construction costs and the increased loss of water through evaporation and canal seepage on the larger distribution system. For any given irrigation development, these factors of increased cost and decreased efficiency in the carriage of water should be balanced against the possibilities for greater over-all benefit to the area concerned. Certainly this method of development should be thoroughly investigated, particularly for possible use in the Great Plains where potential projects often include a much larger acreage of irrigable land than the available water will cover.

Limitations of Integration

It should not be assumed that a pattern of integrated land use can be achieved wherever irrigated lands exist. There are definite limits to integration. This is particularly true of the possibilities of achieving integration within specific operating units.

When new irrigation projects are constructed, the integrated use of irrigated land is made difficult by certain institutional barriers—primarily the landownership pattern, the farm unit pattern, and the type of farming already present. There are two ways in which integration of a new project may be achieved. They are (1) a drastic program of public land purchase and reorganization of the pattern of resource use, or (2) the gradual evolution of a pattern of integrated land use such as has grown up in connection with some of the older irrigation projects. The first is not a practical possibility except under extreme conditions when popular demand and the public interest require that vigorous action be taken. The second procedure leaves the initiative in the hands of the farmers and ranch operators who are likely to move in the direction of integrated land use if experience indicates it to be economically feasible.

Another limitation to the development of integrated land use may be found in the larger capital requirements in an operating unit involving both irrigated land and dry land. It may be beyond the means of many operators to gain control of both irrigated land and dry land, whether by purchase or lease. In the case of a combination of irrigation farming and dry-crop farming, some additional investment in equipment may be required inasmuch as some implements are not adapted to both.

A third limitation concerns the management capabilities of the average operator. It can be argued that most operators might well improve their management of specialized irrigation farms, dry-farming units, or range livestock operations. The development of a pattern of integrated operating units would only serve to spread even thinner the existing inadequate management. Fulton, himself a range livestock operator, observed:

> If this increased hay production is used to winter more cattle and sheep than the range will support during the rest of the year, then the range will suffer. Irrigation development or hay production is not

> a substitute for range management. Instead, these things complicate the management of the range. It seems probable that a large part of any increase in feed made available by irrigation development should be used for fattening operations rather than for breeding stock.[21]

There can be no doubt but that the operation of an integrated unit requires a superior brand of management. The farm and ranch operators who have developed integrated units over a period of years are ordinarily the better operators in the area.

The most definite and obvious limit to the amount of integration which can be achieved is imposed by the physical availability of the resources of an area. In theory, the concept of integrated land use can be presented as an idealistic approach to resource use which goes far beyond the actual possibilities. It is not uncommon for irrigation developments to be justified on the basis of their ability to stabilize surrounding areas. In many instances, the physical availability of resources in the area makes obvious the fact that only a fraction of the new irrigated lands could be integrated with dry lands. It should be equally obvious that the remainder of the area to be irrigated must be justified as self-contained irrigated farms or on some other basis.

The fact that there are limitations to the development of a pattern of integrated land use should not lead one to belittle the importance of the concept. Clawson says, "In most of the strictly range areas, hay can be produced only by irrigation." [22] The contribution that irrigated lands can make to the efficient utilization of other land resources will be enhanced if both the possibilities and the limitations are thoroughly studied and understood.

The Drought of the Thirties

The disaster which struck the Great Plains region during the 1930's was so tremendous as to challenge understanding by the average citizen. A decade later, it was beyond the comprehension of those who did not experience the drought and was fast dimming in the memories of many individuals who did. The great drought

[21] Dan Fulton, "Irrigation Development in Relation to Range Management," *The Montana Stockgrower*, July 15, 1948, pp. 34–35.

[22] Marion Clawson, *The Western Range Livestock Industry* (New York: McGraw-Hill Book Co., Inc., 1950), p. 146.

dramatized the fact that the agricultural economy which had developed in much of the Great Plains lacked the flexibility necessary to permit adjustment to the extremes of the semiarid climate. Some localized areas of the Plains region felt the beginnings of the drought in 1929, 1930, and 1931. The dry period struck in full fury in 1932. Marginal wheatlands as well as lands more justifiably farmed were transformed almost overnight into the infamous "dust bowl." The dust-laden winds deposited the topsoil of the Great Plains as far east as Washington, D.C.

It is difficult to picture the seriousness of the situation that beset the Great Plains. At first, there was optimism that it was just another "dry year" but the situation grew steadily worse. In the words of Tannehill, "The first rainless day in a spell of fine weather contributes as much to the drought as the last, but no one knows precisely how serious it will be until the last dry day is gone and the rains have come again." [23] The determined fight of some farm and ranch operators to stay on and the wild flight of others from the drought-stricken region have been recorded in books and motion pictures. The years of complete crop failures for wheat farmers and the liquidation of livestock herds by ranchers constituted economic losses beyond estimation. The utter defeat of many of the farmers and ranchers of the Plains is nowhere better expressed than by a wheat farmer who battled the drought for seven years and then fled from the dust bowl. He wrote, "My own humble opinion is that, with the exception of a few favored localities, the whole Great Plains region is already a desert that cannot be reclaimed through the plans and labors of men." [24]

Farmer Svobida was wrong. That same Kansas county which he classed as a permanent desert has since produced several wheat millionaires. He was no more in error, however, than the famous novelist in whom the bumper crops which followed the drought period generated a high degree of unwarranted optimism regarding the Great Plains. The novelist argued that technological changes in agriculture had nearly eliminated the determining effect of rainfall (both amount and timing) on the Great Plains wheat crop. He

[23] Ivan Ray Tannehill, *Drought, Its Causes and Effects* (Princeton, N.J.: Princeton University Press, 1947), p. 15.

[24] Lawrence Svobida, *An Empire of Dust* (Caldwell, Idaho: The Caxton Printers, Ltd., 1940), p. 203.

concluded that wheat, a great source of the world's food, had been largely insured against uncertainties in the weather.[25]

These two opinions illustrate the extremes in weather cycles and human reactions. The author of the quoted statement was only one of many defeated Plains residents who left the region, but he did record his experiences in a book. The magazine article by the novelist evidenced the typical lack of understanding of the outsider for the climatic facts of life in the Plains. It is true that great progress has been made in increasing the efficiency with which soil moisture is utilized in dry farming. Adapted tillage methods and soil conservation practices generally have done much to stabilize Great Plains agriculture. Some programs of moisture conservation in the Plains will be discussed later in this chapter. A great deal is yet to be done about both the agricultural economy of the Plains generally and individual farm units before production organization and operations are truly adapted to the caprices of Great Plains weather. At the very time that Mr. Bromfield's article appeared, the forecast of wheat production for 1949 was undergoing almost daily change because of unfavorable weather in the Great Plains.

Extremes of optimism and pessimism, of misery and prosperity, of defeat and achievement have been characteristic of the Plains region throughout recorded history and in prehistoric times. Much money, effort, and human suffering have been expended in fighting the climate of the Plains, but it remains to be seen whether mankind is learning to live with the environment of the region.[26]

The great drought of the 1930's stimulated a number of public efforts to relieve the serious situation on the Plains. These programs included everything from direct relief grants to programs of public works. In large measure they were temporary expedients having small effect on the long-range problem of increasing the stability of Great Plains agriculture. Some programs were designed to have a more lasting effect through the development of the water resources of the region. These are of considerable significance.

[25] Louis Bromfield, "We Don't Have to Starve," *The Atlantic Monthly*, July, 1949, p. 60.

[26] See Vance Johnson, *Heaven's Tableland* (New York: Farrar, Straus & Co., Inc., 1947), for a description of the success and failure of man on the Southern Great Plains, going back as far as the Pueblo dwellers.

The Water Facilities Program

The critical situation on the Great Plains was presented in forcible fashion by the Great Plains Committee of the National Resources Committee which had been appointed by President Roosevelt. This committee had been preceded by the Great Plains Drought Area Committee which rendered a preliminary report in August, 1936. The Great Plains Committee presented its findings and recommendations under the title of "The Future of the Great Plains." In his letter of transmittal to the Congress of the United States, dated February 10, 1937, President Franklin D. Roosevelt wrote:

> The settlers of the Plains brought with them agricultural practices developed in the more humid regions from which they came. By historic circumstance the period of settlement was generally one of rainfall above the average, and, although water was known to be scarce, these practices then appeared to be suitable. The long-run experience, however, has disclosed that the rainfall of the area hovers around, and, for considerable periods, falls below the critical point at which it is possible to grow crops by the agricultural methods common to humid regions. A new economy must be developed which is based on the conservation and effective utilization of all the water available, especially that which falls as rain and snow; an economy which represents generally a more rational adjustment of the organization of agriculture and cropping plans and methods to natural conditions.[27]

In certain major aspects, there was a striking resemblance between the report of the Great Plains Committee and that on "The High Plains and Their Utilization," by Willard D. Johnson in the annual reports of the U.S. Geological Survey for 1899–1901.[28] The importance of small water developments was emphasized by Mead in 1905 when he observed:

> It is one thing to recognize the advantages of irrigation; another to provide for it. It is believed, however, that it is possible to control enough water to irrigate from 1 to 10 acres of land on each of thousands of farms where complete irrigation is not possible, and that this can be done by one of the three following plans: (1) pumping from

[27] Great Plains Committee, *The Future of the Great Plains*, 75th Cong., 1st sess., House of Representatives Document 144, February 10, 1937.

[28] C. Warren Thornthwaite, "Climate and Settlement in the Great Plains," *Climate and Man, Yearbook of Agriculture, 1941* (Washington, D.C.: Government Printing Office), p. 186.

soil water or underground streams; (2) storage in small surface reservoirs of storm waters or the irregular flow of streams; (3) irrigation with flood water wherever it can be had, usually in the winter and spring, generally spoken of as winter irrigation.[29]

The first implementation of the recommendations of the Great Plains Committee came with the passage of the Water Facilities Act of August 28, 1937. The purpose of the Act was stated as follows:

> To formulate and keep current a program of projects for the construction and maintenance in the said areas of ponds, reservoirs, wells, check-dams, pumping installations, and other facilities for water storage or utilization, together with appurtenances to such facilities. The facilities to be included within such programs shall be located where they will promote the proper utilization of lands, and no such facilities shall be located where they will encourage the cultivation of lands which are submarginal and which should be devoted to other uses in the public interest.[30]

The Act appropriated $5,000,000 for the program and placed a limit of $50,000 on the expenditure for any one project. The program has been continued on the basis of annual appropriations in succeeding years. Appropriations by Congress have only been sufficient to take care of a fraction of the requests for water facility loans. The top limit of $50,000 per project remained in force until 1949 when Congress raised the limitation to $100,000 in recognition of the decline in the purchasing power of the dollar.

The Water Facilities Program provides credit and technical assistance to farm operators in the development of water resources which are too small to be within the scope of other public agencies, federal or state. Wherever Soil Conservation Districts are in existence, the Farmers' Home Administration supplies only the financial assistance with the Soil Conservation District providing the technical (engineering) help. When the Water Facilities Program had been in existence for a little more than a decade, loans had been made to more than 7,800 farm families and 5,000 others had received help in solving their water problems through the loans made to ninety-five incorporated associations.[31] Per dollar expended and

[29] Mead, *op. cit.*

[30] U.S. Department of the Interior, Bureau of Reclamation, *Federal Reclamation Laws Annotated* (Washington, D.C.: Government Printing Office, 1947), p. 541.

[31] U.S. Department of Agriculture, Farmers' Home Administration, *Loans for Water in the West*, Washington, D.C., February, 1948.

per acre irrigated, it is likely that these ponds, reservoirs, wells, check-dams and pumping facilities have had a greater stabilizing effect than any other type of water resource development. The importance of the Water Facilities Program in stabilizing the semiarid agriculture of the West is often overlooked because of the small-scale nature of the facilities and because publicity is concentrated on the larger developments.

The Water Conservation and Utilization Program

The next move to implement recommendations of the Great Plains Committee came with the inclusion in the Interior Appropriation Act of $5,000,000 for the construction of water conservation and utilization projects. The WCU projects have been discussed previously but only in their relation to predevelopment work on irrigated farms.

The legislation was a direct result of the recommendations made by the Northern Great Plains Committee in its report of October 14, 1938. Basing its major recommendations on the premise that "the economic and social life of the region must always depend largely on agriculture," the report suggested that a type of agriculture suited to climate, topography, soils, and natural vegetation should replace the cash-grain and small-scale stock-rearing type in many areas where "the latter has failed and cannot succeed." A combination of grazing and feed-crop production, involving larger operating units and supplemental irrigation, was suggested as a feasible and practical substitute.

The report proposed a new irrigation policy designed to make maximum use of funds spent for relief purposes in areas concerned. This policy included the proposal for a single coordinated program for which all costs above reimbursable costs would be supplied from relief funds with preference given to areas of greatest relief load. The program also called for a check of all engineering plans by the Bureau of Reclamation and of agricultural plans by the Department of Agriculture. It was proposed that the latter department would negotiate contracts and have authority to acquire land in order to put into effect a settlement program. The report continued:

> In some instances the difference between the maximum charges for construction, operation, and maintenance which settlers could reasonably pay and the total costs involved might be assumed by relief agencies under cooperative arrangements. Such projects would form economic havens for a considerable number of distressed dryland farmers provided provisions were made to control the settlement of them and to guide for a time the practices of the settlers, unfamiliar with the exacting requirements of irrigation farming.
>
> There also are scattered opportunities for the development of smaller irrigation projects, ranging in size from a few hundred acres to a few thousand acres, by means of storage reservoirs on tributaries or pumping plants on major streams. In most instances the feasibility of their development is contingent upon cooperative possibilities noted for larger projects. They should be undertaken with a view to integrating the management of forage production with that of grazing on adjacent lands. Finally, there are numerous opportunities for small developments of underground and surface waters under the Water Facilities Act. They would improve stock-water supplies and perhaps furnish some water for supplemental irrigation.[32]

The Interior Appropriation Act of 1940 provided that the $5,000,000 appropriated for water conservation and utilization projects in the Great Plains was to be expended not through the Secretary of the Interior but by federal agencies to be designated by the President. The Act stated:

> For construction, in addition to labor and material to be supplied by the Works Progress Administration, of water conservation and utilization projects, including acquisitions of water rights, rights of way, and other interests in land, in the Great Plains and arid and semi-arid areas of the United States to be immediately available, $5,000,000, to be allocated by the President, in such amounts as he deems necessary, to such Federal Departments, establishments, and other agencies as he may designate, and to be reimbursed to the United States by the water users on such projects in not to exceed forty annual installments: *Provided,* that expenditures from Works Progress Administration funds shall be subject to such provisions with respect to reimbursability as the President may determine.[33]

The broadening of responsibility for irrigation development to include federal departments and agencies other than the Bureau of Reclamation was a new concept. Most important of the agencies cooperating with the Bureau of Reclamation was the Farm Security

[32] Preliminary Report of the Northern Great Plains Committee, "Rehabilitation in the Northern Great Plains" (mimeographed), October 14, 1938.
[33] *Federal Reclamation Laws Annotated,* p. 571.

Administration of the Department of Agriculture. Financial aspects of the Farm Security Administration activities were stated in the Act of August 7, 1939. The Secretary of the Interior was authorized:

> . . . (1) to consider the money or any part of the money made available to settlers or prospective settlers by the Farm Security Administration, as all or a portion of the capital required of such settlers under subsection C of section 4 of the Act of December 5, 1924 (43 Stat. 702); and (2) where such farm units have been or may be improved by means of funds made available by the Farm Security Administration, to require an entry man of any such unit to enter into a mortgage contract with the Farm Security Administration to repay the value of such improvements before an entry is allowed.[34]

Use of the irrigated lands developed in the WCU projects as a tool in adjusting the drought-stricken agriculture of the Great Plains and rehabilitating the displaced families was directed in the Interior Appropriation Act of 1941. The Act of June 18, 1940, stated:

> It is hereby declared to be the policy of the Congress that, in the opening to entry of newly irrigated lands, preference shall be given to families who have no other means of earning a livelihood, or who have been compelled to abandon, through no fault of their own, other farms in the United States, and with respect to whom it appears after careful study, in the case of each such family, that there is a probability that such family will be able to earn a livelihood on such irrigated lands.[35]

The above series of legislative acts constituted an official recognition that irrigation development is a problem of concern to many individuals and agencies other than the engineering profession and that the benefits of irrigation development can be extended to the surrounding dryland areas.

The WCU Program and Integrated Land Use

The provisions of the Water Conservation and Utilization Act of 1939 and the amending legislation of 1940 were carried into effect in several areas of the northern Great Plains. One of the projects which received the most attention is located in Dawson County in eastern Montana. The Bureau of Reclamation had begun construction of the Buffalo Rapids Project, Division 1, on the Yellowstone River during the worst of the droughts as a work relief

[34] *Ibid.*, p. 606.

[35] *Ibid.*, p. 621.

measure for distressed farmers in eastern Montana. Construction was carried on in cooperation with the Works Projects Administration. The Buffalo Rapids Project was included in the Water Conservation and Utilization Program in 1940.

Dawson County was typical of much of the Great Plains region in the throes of the drought. A series of crop failures, farm units too small except in the most favorable years, and a discouraged population made the area a fertile field for attempting adjustments in the use of resources. The Farm Security Administration carried on a detailed study of the land and human resources of the county. The basic objective was to provide a fund of information which could guide technicians and farmers in utilizing the Buffalo Rapids Project in such a way as to achieve the maximum in resource adjustment of the surrounding area.[36] Specifically, information was sought as to the location and situation of farmers who were at a disadvantage in comparison to their more fortunate neighbors. Possibilities were sought of selecting settlers for the new irrigated farms in such a way that the resources they left behind might have maximum effect in adjusting small units and adding to inadequate resources. Land resources vacated by resettlement clients could be used to enlarge inadequate units of operators remaining in overcrowded dryland areas.

Other opportunities were examined for removing all operators from areas submarginal for crop production and returning such areas to grass. These grass areas could be used by settlers on the irrigation project as community pastures, thus applying on a planned basis, one of the methods of integrated land use previously discussed in this chapter. Other possibilities were studied of stabilizing existing ranches in the dryland area by providing feed-base units without buildings on the new irrigated lands.

In the attempt to spread the stabilizing effects of the Buffalo Rapids Project as far into the surrounding dryland area as possible, a study was also made of the next county to the northwest.[37] The

[36] For a detailed discussion of the Dawson County study see J. L. Paschal and P. L. Slagsvold, "Irrigation Development and Area Adjustment in the Great Plains," *Journal of Farm Economics*, XXV, No. 2 (May, 1943), 433–43.

[37] Roy E. Huffman and John R. Justice, "Adjusting the Agricultural Economy of McCone County, Montana, with the Assistance of the Water Conservation and Utilization Program," Unpublished report, U.S. Department of Agriculture, Farm Security Administration, Denver, Colo., May, 1941.

distance from this area to the irrigation project varies from twenty-five to fifty miles.

The Water Conservation and Utilization Program was also put into effect around the Buford-Trenton Project on the Missouri River in northwestern North Dakota. A similar study was made of the dryland area adjoining the WCU project then under construction.[38] The study revealed exceptional opportunity for integrated use of the irrigated lands and adjoining grazing lands. A block of 65,000 acres adjoining the irrigation project appeared to present an ideal situation for the organization of a grazing district. Blocks of publicly owned lands, particularly county-owned lands which do not lie within an area of definite land management (national forests, grazing districts, etc.), usually indicate conditions favorable to the formation of a grazing association. Nearly 40 per cent of this particular area was in public ownership in May, 1941. Williams County owned 15,092 acres available for lease or sale. The federal government, the State of North Dakota, and the Bank of North Dakota held the rest of the publicly owned land. In addition, another 21 per cent of the area was five years or more tax delinquent, indicating that it would probably be taken over by the county and sold.

Resident individuals owned 42 per cent of the area, but many of these owners were not residing upon their land and much of this land was unoperated. Corporate and nonresident owners held 18 per cent of the area.

After the detailed investigation of this area was completed, the federal government, acting for the Buford-Trenton Cooperative Association, took an option on 14,413 acres of county land. Steps were taken to option additional land, but no attempt was made to acquire land owned or leased by present operators until they voluntarily vacated their holdings.

The advent of World War II brought a restriction in the activities of many civilian government agencies. Construction of the irrigation works for the Buford-Trenton Project was completed, but planning and action concerned with the economic and social aspects of the project came to a sudden halt. The options on the proposed

[38] Roy E. Huffman and James L. Paschal, "Integrating the Use of Irrigated and Grazing Land in the Northern Great Plains," *Journal of Land and Public Utility Economics,* XVIII, No. 1 (February, 1942), 17–27.

grazing area expired, and much of the land has been incorporated into individual operating units during the succeeding years of favorable rainfall.

It is to be regretted that one of the projects planned for integrated use of irrigated land and dry land could not have been carried through to completion. The Buford-Trenton Project presented an outstanding opportunity for the use of irrigated land in conjunction with a grazing district. Public funds for studies and planning had been expended to the point where acquisition of a nucleus of grazing land was the only step to be completed before the area could be placed in the hands of an association of farmers on the irrigated land for organization and operation as a cooperative grazing district. Such a development would have provided an excellent test of the practicability of planning and aiding the development of integrated land use around new irrigation projects.

Studies of Integrated Land Use

We have noted previously that integrated use of irrigated lands and dry lands has developed naturally in many areas. A few research studies reveal the extent of integration in different areas. One of the first studies to discuss the place of integrated land use in the development of an irrigation project was published in 1930. The utilization of the forest and foothill grazing lands around the Flathead Irrigation Project in northwestern Montana was discussed by Sherman E. Johnson:

> The Flathead Project is the one large area of irrigated land capable of furnishing winter feed for livestock that can be grazed on the above lands. A development policy for the project must therefore consider the feasibility and the economy of utilizing the surrounding grazing land in connection with this body of irrigated land.[39]

Johnson's study pointed out that most of the grazing lands in the area were not being utilized. Although construction of the Flathead Project was begun in 1917, Congress did not provide funds for its completion until 1928; so the development had not taken final form at the time of the study.

[39] Sherman E. Johnson, *An Economic Analysis of Production Problems on the Flathead Irrigation Project,* Montana Agricultural Experiment Station Bulletin 237, December, 1930, p. 48.

A study of the integration existing between irrigated lands in the North Platte Valley of Nebraska and surrounding dryland revealed that, with respect to the 175 farms studied in 1946:

1. The integration between the valley and the surrounding dryland country comes about through the use of a common market for both the purchase and the sale of farm products and for the purchase of common goods.
2. Less than 8 per cent of the valley farms were full-scale integrated irrigated and dryland operating units. Only 3 per cent of the farms had dry cropland lying outside the project area, and only 5 per cent had pasture land outside the project area.
3. Of the valley-farm operating units, 15 per cent hire the use of dryland pasture for summer grazing outside the project.
4. Exceeding in importance the integration found within operating units is that brought about through the exchange of livestock and livestock feed. This exchange is mostly the result of livestock feeding operations undertaken by 40 per cent of the valley farmers in 1946.[40]

A study, also made in 1946, of integration in connection with the Huntley Irrigation Project and the Milk River Irrigation Project in Montana revealed almost the reverse of the situation found in Nebraska. These two projects are early Bureau of Reclamation developments. More than four-fifths of the 108 farmers contacted on these irrigation projects reported some type of integration. Of the 50 farms studied on the Milk River Project, 78 per cent grazed some livestock on range land which was owned, leased, hired, or obtained by permit, and 56 per cent farmed dry cropland. Fifty per cent of the 58 farms studied on the Huntley Project had range land and 36 per cent had dry cropland. Feed and livestock exchange were less important.[41]

Another Montana study, in which a consideration of integrated land use was incidental to the main theme, showed integration to

[40] Elco L. Greenshields and Stanley W. Voelker, *Integration of Irrigated and Dryland Farming in the North Platte Valley in 1946*, U.S. Department of Agriculture, Bureau of Agricultural Economics, in cooperation with the U.S. Department of the Interior, Bureau of Reclamation, Washington, D.C., December, 1947.

[41] Ralph E. Ward and M. M. Kelso, *Irrigation Farmers Reach Out into the Dryland*, Montana Agricultural Experiment Station Station Bulletin 464, September, 1949.

be an important feature of farm organization. The one hundred farms studied were distributed over irrigated lands developed by the federal government, by the State of Montana under the Carey Land Act, and by private ditch companies. Sixty-five per cent of the farms had dry cropland and/or range land.[42]

Studies of two WCU projects previously discussed showed marked differences in the extent to which integrated land use has developed. Little integrated use of land within farm units has appeared on the Buffalo Rapids Project in Montana.[43] On the other hand, 53 per cent of the operators on the Buford-Trenton Project in North Dakota have from 160 to 1,100 acres of dry cropland. Some have one to four sections of range land in addition to cropland.[44]

A study of farmer reaction in a dryland farming area in the process of being developed for irrigation showed that, "A majority of the farmers expressed a preference for part-irrigated and part-dryland farming, even though there are conflicts between the irrigating and the harvesting of small grains on the dryland part of the farm."[45] This preference may indicate a desire to combine the stability of irrigation farming with the high-income possibilities of dryland farming during favorable weather periods.

The extent and predominance of types of integration will vary from project to project as indicated by the great differences in the situations around regular Reclamation Act projects in Nebraska and Montana and around WCU projects in North Dakota and Montana. Such differences may be the result of climate, soils, major land uses, type of control of adjoining lands, cropping systems, and the characteristics of the irrigation project itself including its shape; for example, a large block of irrigated land will evidence less integration than the "shoestring" type of development.

[42] Roy E. Huffman and D. C. Myrick, *Farm Organization and Production Requirements in Selected Irrigated Areas*, Montana Agricultural Experiment Station Bulletin 453, October, 1948, p. 11.

[43] Clyde E. Stewart and D. C. Myrick, *Control and Use of Resources in the Development of Irrigated Farms*, Montana Agricultural Experiment Station Bulletin 476, October, 1951, p. 45.

[44] Stanley W. Voelker, *Settlers' Progress on Two North Dakota Irrigation Projects*, North Dakota Agricultural Experiment Station Bulletin 369, June, 1951, p. 23.

[45] Ned O. Thompson and Robert L. Berger, *From Dryland Farming to Irrigation*, U.S. Department of Agriculture, Bureau of Agricultural Economics, Lincoln, Neb., June, 1946, p. 2.

Irrigation from Small Watersheds

It has been pointed out earlier that small, individual water developments are usually overshadowed by large projects and that such small water-conservation endeavors often yield the greatest stabilizing effect per dollar of cost. Where conventional irrigation is not possible because of the absence of permanent streams, many ranchers have constructed water-spreading systems of dikes on hay lands and, in some instances, on range land. The water-spreading systems are designed to hold back flash floods and heavy runoff and to spread the water over the land rather than permitting it to run unutilized down the coulees and stream channels.[46]

Such water-spreading systems can be constructed with ordinary farm equipment or with more efficient dirt-moving equipment. Some of the early developments of this type were constructed with teams of horses and scrapers. In some cases, the dikes have been built using an ordinary farm tractor and moldboard plow.[47] Such water-spreading systems may make the difference between success and failure during drought periods in some semiarid areas.

State Programs for Small Water Projects

There is a great need for irrigation development of these areas which are too large or too difficult for an individual to develop by himself, or with the technical assistance of public agencies, and which are not large enough to have been considered for development by the Bureau of Reclamation. Many people feel that the gap between individual development and large-scale federal development is the most critical problem in present-day irrigation policy and programs. It has been suggested that, "Small irrigation facilities should not always be thought of as simple installations. Some may be simple, but there are many factors that challenge the best technicians. . . ." [48]

[46] Floyd D. Larson, "Irrigation Comes to the Ranges and Ranchers of Carter County, Montana," *Western Livestock Reporter*, March 2, 1949.

[47] Clarence F. Vogel, "Irrigation by Water Spreading," *Agricultural Engineering*, February, 1949, pp. 84–85.

[48] H. F. McColly, "Small Irrigation in the United States," *Agricultural Engineering*, July, 1946, pp. 307–10.

Some of the western states have established agencies which fill in varying degrees the need for organized development of small projects. In a survey of the seventeen reclamation states, Buck found that

> . . . there are eleven states that have no construction agency of any kind that can build small projects. Montana has the only Board that is actually engaged in this type of work, although Wyoming has the authorization to construct irrigation and drainage works if and when the legislature appropriates the funds. Several of the states have boards that can finance irrigation and drainage districts but the actual construction work is not done by the state board.
>
> In Montana, North Dakota, and Washington, the Boards can issue bonds; Montana and North Dakota can borrow money; projects can be financed in Oklahoma, Utah, and California (for flood control), North Dakota (aid in drainage), and Washington (for irrigation, drainage, and diking). The only Boards that own any construction machinery are Montana and Oklahoma.
>
> Acts creating the Boards in North Dakota and Utah have been largely patterned after the Montana Act. . . .[49]

Another approach to the problem of small-project development has been suggested by the National Reclamation Association. In annual meetings for the past several years, the Association has adopted resolutions urging that the Bureau of Reclamation establish a small-projects division. To date, no action has been taken.

[49] Fred E. Buck, "State Responsibility for Small Project Development," *Proceedings of the Seventeenth Annual Meeting of the National Reclamation Association*, Oklahoma City, November 17–19, 1948, pp. 205–22.

CHAPTER 10

River Basin Development

The people of the United States have begun the job of developing the last natural-resource frontiers within the continental limits of the nation—our great river valleys. For many years, most of the major rivers of the country have flowed to the seas and contributed only a fraction of their potentiality to the wealth and well-being of the people. On occasion, usually every spring, those same rivers go on a rampage with resultant property losses in the millions of dollars and human suffering beyond calculation. The complete development of the resources of a river basin for the benefit and protection of its residents and the rest of the nation is a job of great intricacy and scope. The opportunities presented are as challenging to the imagination as the unsettled West was to our pioneer forefathers. These new frontiers require the same breadth of vision, too, and necessitate an understanding of the goals to be achieved. One person expressed the problem very well when he said that the nation would get only one chance to remake its river basins and that it had better do a good job. That job involves more than moving dirt and building structures. It means a complete evaluation of the natural and human resources present, with the ultimate objective of improving the economic and social status of the people.

The Concept of Multiple Use

The river basin approach to development of resources places major emphasis on the use of water for all purposes. This concept is commonly referred to as *multiple-use* or *multiple-purpose* development. The multiple use of national forest lands became an important factor in public land management some time before it was accepted as the core of water resource development. There are five major purposes or uses of forest lands: (1) timber production, (2) watershed services, (3) recreation, (4) support of wildlife, and

(5) forage production.[1] These multiple uses of land are also associated with the multiple use of water resources.

Many early water-storage projects presented opportunities for use other than the one purpose recognized in the original plans and construction. Multiple-use features of projects, however, were largely incidental and accidental. Congress had provided authorization for public power development by the Bureau of Reclamation in 1906.[2] The first truly multiple-purpose project, specifically authorized and designed as such, to be built was the Boulder Canyon Project (Hoover Dam). Enacted in 1928, the legislation recognized flood control, navigation, water storage for irrigation, and hydroelectric power generation as purposes of the project.[3]

As these multiple-purpose potentialities became evident to more and more people, there has been increased emphasis on the study and evaluation of all possible uses in planning for resource development. Public undertakings which are classed broadly as *flood control projects* "are beginning to look beyond mere flood control to the harnessing of our rivers as great creative resources."[4] Cooke has written, "It is a denial of Nature to regard water or any of the developments normally associated with water as single problems. Water is one part of the great complex we call Nature. When we make an alteration in any one part, we automatically alter in some degree all the other parts."[5]

Westerners are inclined to think of river basin development primarily in terms of an irrigation program. Irrigation is important but it is only one phase of multiple-purpose resource development. A complete listing of water uses would include irrigation, hydroelectric power, flood control, domestic and industrial water supplies, pollution control, navigation, fish and wildlife, and recreation. The relationships among these uses may be competitive, complementary, or supplementary. As a result, multiple use of storage reservoirs

[1] R. E. Marsh and William H. Gibbons, "Forest-Resource Conservation," *Farmers in a Changing World, Yearbook of Agriculture, 1940* (Washington, D.C.: Government Printing Office), p. 461.

[2] Marion Clawson, *Uncle Sam's Acres* (New York: Dodd, Mead & Co., 1951), p. 208.

[3] U.S. Department of the Interior, Bureau of Reclamation, *Federal Reclamation Laws Annotated* (Washington, D.C.: Government Printing Office, 1947), p. 340.

[4] Ward Shepard, *Food or Famine: The Challenge of Erosion* (New York: The Macmillan Co., 1945), p. 140.

[5] Morris L. Cooke, "On Water Resources," *Journal of Soil and Water Conservation*, VI, No. 1 (January, 1951), 10–14.

has required certain changes in design and operation. As yet, there is not a great deal of standardization in the measures adopted from year to year in the allocations to different purposes or in the methods of operation.[6]

The close relationship between new irrigation and hydroelectric power development has been referred to by some writers as a "partnership." This expression emphasizes the fact that most future irrigation projects are economically feasible only if earnings from power sales are available to pay part of the construction costs. In many instances, the primary importance of hydroelectric power generation has relegated present-day irrigation development almost to the status of a by-product of power production. Within the multiple-use concept, however, irrigation remains an important factor in the total use of resources and in repaying a portion of the costs.

A development program based on multiple use of water and land will have a profound effect on the economy of many predominantly agricultural areas of the West and will enhance the possibilities of industrialization. By the construction of new farms on new irrigation projects a part of the population loss resulting from agricultural adjustments will be offset. These adjustments, associated with the inadequate size of the original homesteads and the continuing impact of technology, are contributing to the trend toward larger and fewer farms and ranches. Less significant population gains can be expected to result, however, from development of the new irrigated lands than from some of the associated water uses. Major population gains will have to be the result of industrial development. Industrialization and some increase in population can be important factors in solving the perpetual problem inherent in providing costly public services in an area of sparse population.

Multiple-purpose development of water resources complicates the problem of allocating a scarce supply of water in many areas. This is particularly important in the case of some processing and manufacturing industries which are heavy consumers of water. Many agricultural areas of the West have been concerned with only one consumer use of water—irrigation. Industrial development means that, for the first time, they must face the problem of com-

[6] Wesley R. Nelson, "What Multiple Purpose Means," *Reclamation Era*, XXXIII, No. 7 (July, 1947).

petition for the available supply of water by other users than agriculture. In addition to competing for water, some of the most important industrial users create serious problems by returning polluted water to watercourses which are the source of supply for other users downstream. Finally, there are the detrimental effects of such pollution on fish life and on the recreational uses of the water resource. Whatever the particular competitive situation, it must be faced and resolved by the people who will be living with it.

Straight Lines and Curves

Americans have demonstrated an amazing talent for establishing boundaries and lines of demarcation on the earth's surface having little or no relationship to economic, social, or natural forces. They are equally amazing in their insistence that these man-made lines must be preserved at any and all costs. Many of these lines—township, county, and state boundaries—will always remain as the limits of governmental authority even though many a citizen would find it convenient and in the common interest if he were part of a community designed according to the topography of the region in question. Even road builders have found it necessary to make some concessions to nature and it is not unusual that a farmer's best road to market is to the county seat of the adjoining county. Let that farmer and his neighbors petition for transfer of their community to the more convenient county, however, and, even though the total area involved may be insignificant, you will have an example of the vociferous insistence on preserving man-made boundaries.

Why this peculiar insistence on man-made straight lines when the earth itself is round and most of nature's handiwork takes the form of curves? There is more of a tendency for boundaries to conform to natural land features in the eastern United States than in the western portion of the country. It was common practice to extend a boundary due west into the wilderness for an indefinite distance. Tennessee is a good example of this.

With some notable exceptions, the West is a land of straight-line boundaries. The basis for this situation lies primarily in the rectangular system of survey. The rectangular or "grid" system of survey was designed with no consideration given to its relationship

to the topography of the land concerned. It was an easy, convenient, and rapid method for dividing up a vast area of unsettled country. And since the big problem was to get the land into private hands, this method of survey was extremely useful in that it facilitated the disposal of the public domain. The rectangular system of survey is a marvelous instrument so far as ease of land description and recording of land titles is concerned. As a means of securing an equitable division of land resources or of shaping land boundaries to the curves of nature, it has been a first-class failure. Straight lines have little in common with the behavior of water.

A River Basin Defined

At this point, it is necessary to formulate a definition for a river basin or drainage basin. Many people think only of the lands immediately adjacent to the river itself. It should be understood that a river basin includes all of the resources of that drainage area back to where the divide breaks over into another drainage basin. An area 1,300 miles long and 700 miles wide is influenced by the waters of the Missouri River and its tributaries. This great river basin extends from St. Louis, Missouri, to the Continental Divide where it breaks over into the Columbia River Basin which extends on to the Pacific Ocean. The term "watershed" is sometimes used synonymously with river basin or drainage basin, although it is more frequently used with reference to smaller drainage basins and particularly with reference to land management units.

A comprehensive development program for a river valley involves working with three resources of equal importance—water, land, and people. In the past, water has tended to receive major emphasis, while the other two factors played a minor role or were disregarded altogether in project and program formulation. Irrigation development by the Bureau of Reclamation together with flood control and development of navigation by the Army Engineers have focused public attention on the water resource.

The importance of the land in any program of comprehensive river basin development should be obvious. And yet, the vital influence of the land has often been ignored, perhaps because too many people fail to recognize the inseparability of land and water problems. Every square foot of a drainage basin plays a part in the water

runoff which creates flood control problems and affects the supply of water for economic use. This is true whether the lands are part of the headwaters or of a lower agricultural watershed.

The third major resource involved in river basin development, the people, has received far too little attention and, many times, has been completely ignored. A comprehensive development program for a river basin is of profound significance to every man, woman, and child within the confines of that drainage area. Their ways of living and of making a living are likely to be affected to a significant degree. Increased job opportunities, better public services, and improved community life can be the results of comprehensive river basin development. The people are certainly concerned with all of these potential benefits as well as any detrimental effects of the program.

Water and Land

It has been observed, "The river is a product of its watershed and it is on the watershed that people earn their living. . . . The river and the watershed go together, as a unit, to make up the natural resources of the region. And whether a region is a liability or an asset to the nation depends upon the quantity and quality of the resources it has and the way that people use them." [7] The way in which land is used—cropland, grazing land, and forest land—is important in the quantity, quality, and timeliness of water flow. The land itself still remains the best storage reservoir for water. The quantity of water stored in nature's underground reservoirs greatly exceeds the capacity of all surface reservoirs in the country, both natural and artificial, possibly excluding the Great Lakes.[8]

One writer has listed five factors influencing the amount of water absorbed into the ground-water reservoir: [9]

1. The porosity of the soil or rock
2. The topography of the surface

[7] Tennessee Valley Authority, *The Valley Is Paying Off* (Washington, D.C.: Government Printing Office, 1949), p. 37.

[8] Walter N. White, Discussion of "Surface Run-off Control" by Robert E. Horton, Upstream Engineering Conference, Washington, D.C., September 22–23, 1936.

[9] William Peterson, Discussion of "Basic Principles of Water Behavior" by Thorndike Saville, Upstream Engineering Conference, Washington, D.C., September 22–23, 1936.

3. The rate of rainfall
4. The amount of vegetation on the surface
5. The dryness of the atmosphere

The rate and amount of absorption of water is increased by a vegetative mulch in the upper soil. Vegetation retards the flow of surface water thus giving it more time to sink in and permitting less to run off. The point is made clear by the statement that "The smallest dam in the world is a blade of grass." [10]

Land-use practices which tend to retard runoff and place a maximum of the water in the ground will result in greater uniformity of stream flow throughout the year. No one should be more interested in this than the irrigation farmer who depends on the water-yielding ability of a drainage basin for his season's supply of that "fifth factor of production." Isaiah Bowman has pointed out that "if we lived in the desert and our lives depended upon a water supply that came out of a steel tube, we would inevitably watch that tube and talk about it understandingly." [11] The irrigation farmer is not alone in his lack of a complete understanding of the relationship of his well-being to what goes on throughout the watershed in which he lives. Other groups do not evidence much recognition of their relationship to the situation unless and until the supply of water begins to fall.

Flood control work has advanced to the point where whole rivers are treated as units but still in terms of engineering structures on the main stream. This amounts to trying to handle water as if it and the channel in which it flowed were independent phenomena. The right approach would be to treat watersheds as units. As Shepard wrote, the problem is "not to do less river control, but to do more land control." [12]

The problem of water control through land management in a drainage basin seems to fall naturally into two geographic areas. They are the headwaters portion of the basin involving largely forest lands and grazing lands and the agricultural portion of the watershed made up primarily of cultivated croplands with some grazing lands.

[10] Jay Franklin, *Remaking America* (Boston: Houghton Mifflin Co., 1942), p. 106.

[11] Isaiah Bowman, "Influence of Vegetation on Land-Water Relationships," Upstream Engineering Conference, Washington, D.C., September 22–23, 1936.

[12] Shepard, *op. cit.*, p. 144.

The Importance of Headwaters

The use of most forest lands and a part of the grazing lands is subject to public control and supervision through the Forest Service, the Bureau of Indian Affairs, the Bureau of Land Management, the Soil Conservation Service, and certain state agencies. Watershed protection is described as "a prime function of forests" in a recent report which discusses the place of water use and control in regional resource development. The report goes on to say:

> Water and soil not only sustain forests but are in turn profoundly affected by them. This influence extends far beyond the forest land itself. Water is a product of most lands, and our 624 million acres of forests materially affect its disposition and usefulness. Moreover, forests are guardians of the soil, keeping it in place for productive purposes and out of streams and water-storage works where it is harmful.[13]

Watershed management is primarily a public responsibility although all forest lands important in water control are not in public ownership. Publicly owned forest lands should provide the pattern of use and management for privately held forest lands. The public interest extends to these lands as it does to other types of private land in the watershed. Private owners have little incentive in watershed management since it yields no direct revenue and is largely beneficial to others.[14]

The national forests have been referred to as "our oldest and most solidly established conservation enterprise."[15] The importance of these vast areas of public lands to the problem of water resource development is shown by statistics in a report released by the Forest Service. The national forests of the eleven western states occupy one-fifth of the total land area but supply more than one-half of the total stream flow in these states. The report further revealed:

> Fifty-three per cent of precipitation on national forests eventually runs off as stream flow. Outside the national forests, only 22 per cent of precipitation gets to streams and rivers. Part of the explanation is that forests act like blotters, soaking up water and then letting it

[13] U.S. Department of Agriculture Forest Service, *Forests and National Prosperity*, Miscellaneous Publication 668 (Washington, D.C.: Government Printing Office, 1948), p. 69.

[14] *Ibid.*, p. 70.

[15] Shepard, *op. cit.*, p. 68.

trickle down gradually in the spring and summer. Also evaporation is less in the high, cool areas than in the lowlands.[16]

Much of the water available for multiple-purpose development is, then, a product of a land resource which must be managed with multiple uses of that land being kept constantly in the foreground. The opinion has been expressed that "the biggest problem in wild land administration in the Northwest today is to obtain the type of management needed for desirable multiple-use benefits." [17] The water yield from many areas depends on the total amount of precipitation and the seasonal distribution of precipitation. Balanced against these is the use and loss upon the same watershed. It is here that watershed management plays an important part in obtaining the optimum yield of high-quality water.[18] The protection, utilization, or manipulation of the forest or range cover and soil mantle have an important bearing on the hydrologic behavior of the land.[19] Bailey points out:

> Watershed management differs but little from forest and range management, except in objectives. The primary objectives of forest and range management are maximum sustained yields of highest quality timber and forage, whereas the objective of watershed management is the production of maximum quantities of usable water. This generally means minimum peak discharges, a better sustained flow, and maximum stability of soil or slopes and of materials that make up the valley fills.[20]

What does the optimum yield of water mean in terms of the forest or forage cover on a watershed? This is the crucial point in watershed management because the water yield must be related to other uses including timber production based on forest cover and grazing of livestock based on forage cover. Discussing the water consumed by the forest itself, Wilm wrote:

[16] U.S. Department of Agriculture Forest Service, News Release, Washington, D.C., February 17, 1950.

[17] M. B. Dickerman, "The Meaning of Conservation," *Proceedings of the Western Farm Economics Association*, Pullman, Wash., and Moscow, Idaho, June 28–30, 1950, pp. 133–40.

[18] W. G. McGinnies, "Maintaining Water Yield in Upper Watersheds," *Proceedings of the Great Plains Agricultural Council*, Laramie, Wyo., July 29–31, 1948, pp. 8–10.

[19] Reed W. Bailey, "Reducing Runoff and Siltation Through Forest and Range Management," *Journal of Soil and Water Conservation*, III, No. 1 (January, 1948), 24–31.

[20] *Ibid.*

> . . . a forest does consume water to be sure, as part of its life processes. In some areas this toll may be only a fair price for the timber produced, or it may be very cheap insurance against costly damage; where floods and erosion present a real problem, the densest possible forest cover may be best because it provides maximum infiltration capacities and protection to the soil. Where the rush of floods is not great, however, and water is valuable—as in many mountain areas throughout the west—the cost of watershed protection by forest cover may greatly exceed its benefits; then it may be desirable to reduce the forest to the minimum density compatible with sustained production of water and of other forest resources.[21]

Grazing of livestock on public lands often comes in conflict with programs to prevent erosion and maintain watershed values. As in the case of forests, grazing lands should be managed in such a manner that a balance is struck which gives due consideration to the relative values of grazing and water yield. The conflict can become especially difficult if a watershed is so eroded and the vegetation so depleted that it becomes necessary to exclude all livestock until a satisfactory forage cover has been re-established.[22]

The benefits of water yield are less obvious and less direct in many instances than the returns to competing uses. For that reason, "land managers are cautioned against subordinating watershed services to other uses at the expense of the public welfare." [23] The public interest is especially acute in the arid and semiarid West where the maximum yield of usable water is essential because water is the key to the entire economic and social structure.[24]

Agricultural Watersheds

Watershed control in agricultural areas involving large numbers of independent operating units is, possibly, an even more complicated problem than the headwaters which are largely controlled by public agencies. Agriculture has been exploitive of soil fertility in

[21] H. G. Wilm, "The Status of Watershed Management Concepts," *Journal of Forestry*, XLIV, No. 11 (November, 1946), 968–71.

[22] W. R. Chapline, "Multiple Use of Summer Range and the Place of Research in Range Land Conservation," *Journal of Forestry*, XLI, No. 10 (October, 1943), 716–21.

[23] Charles A. Connaughton, "Yield of Water as an Element in the Multiple Use of Wild Land," *Journal of Forestry*, XLI, No. 9 (September, 1943), 641–44.

[24] Earle H. Clapp, "Management and Use of Forest and Range Lands," *Headwaters Control and Use*, Upstream Engineering Conference, Washington, D.C., September 22–23, 1936.

many instances with a resultant decrease in the ability of the land to absorb precipitation and an increase in runoff. The hazards of cultivation have long been recognized. George Washington and Thomas Jefferson were both advocates of soil and water conservation techniques.[25] The majority of American farmers, however, adopted a more exploitive attitude toward their land. The conservation of resources in the United States has been hindered by the long-existing belief that the nation is blessed with inexhaustible resources. It has been noted that "The whole philosophy back of our early land settlement considered natural vegetation—the grasses of the plains and the prairies, the forests of the humid region—merely as something temporary, to be quickly disposed of in order to prepare the land for its ultimate highest use, namely, agriculture." [26]

Utilization of agricultural lands in such a way as to provide adequate water control necessitates major changes in some segments of American agriculture. Case has observed, "Prevention of flood waters in the streams requires good farming practices in the watershed so as to prevent excessively rapid run-offs of heavy rains. The necessity of complete reorganization of many farms over a large area gives rise to problems of significance to both the individual farmer and the economy as a whole." [27] Perhaps the most important change needed is in the basic attitude of many farm operators toward the resources with which they work. There is a definite need for a philosophy of conservation among those privileged to own and use land—a realization that proper land use is an obligation and not something which should depend primarily on government payments.

A conservation program on agricultural lands is made up of the total of accomplishments on individual farms and ranches. Most farm and ranch operators are dependent on their units to provide a living. It is probable that the conservation objective would be helped by less publicity for what certain individuals—subsidized by

[25] Walter C. Lowdermilk, Discussion of "Influence of Vegetation on Land-Water Relationships" by Isaiah Bowman, *Headwaters Control and Use*, Upstream Engineering Conference, Washington, D.C., September 22–23, 1936.

[26] Raphael Zon, "Natural Vegetation as a Key to Conservation Practices," *Conservation of Renewable Natural Resources*, University of Pennsylvania Bicentennial Conference (Philadelphia: University of Pennsylvania Press, 1941).

[27] H. C. M. Case, "Farm Management Research in the U.S.A.," *International Journal of Agrarian Affairs*, I, No. 2 (October, 1947), 7–16.

Hollywood—are able to do on their show places and more consideration of the conservation techniques involving little or no additional cost which are within reach of the average farmer or rancher. Many operators are working with limited financial resources, and conservation is only one of several alternative uses for available capital. Less publicity might well be given to the dramatic process of remaking a widow's farm in a day with an army of bulldozers and carryalls. It would seem that both of the above-mentioned publicity subjects might tend to give the farm or ranch operator the impression that conservation is impossible without great financial subsidies or extreme amounts of government assistance. So simple a conservation technique as the contour furrow has been referred to as "one of the most important inventions of the human race" and "man's greatest defense against future hunger." [28] Widespread adoption of contour furrowing is not concerned with the problem of capital investment, of course, but with the problem of public education. Great strides have been made through the educational efforts of the Agricultural Extension Service and the Soil Conservation Service.

The above is not intended to discount in any way the need for programs of soil and water conservation. It is intended to emphasize that the bona fide farm or ranch operator has to take into consideration the immediate effects of a conservation program on his costs and income as well as its long-term aspects.[29] Beyond the possibilities of individuals to undertake needed conservation lies the whole field of public responsibility and effort. Discussing the place of agricultural lands in upstream engineering, Dr. Bennett described the problem as involving a broad field of effort including

> . . . an amalgamation of technical knowledge from many fields of scientific endeavor, inviting the engineer, the forester and the agronomist; the climatologist, the economist, and the sociologist; and many others to pool their efforts in a coordinated, carefully balanced plan for the efficient regulation and wise use of both land and water along the headwater drainages of our streams, even to the uppermost limits of the most diminutive streamlet and its enclosing watershed.[30]

[28] Shepard, *op. cit.*, p. 54.

[29] See William G. Murray, Earl O. Heady, and John F. Timmons, "Economic Aspects of Soil Conservation Problems," *Journal of Soil and Water Conservation*, IV, No. 1 (January, 1949), 17–20.

[30] H. H. Bennett, "Management and Use of Agricultural Lands Including Farm Woods and Pastures," *Headwaters Control and Use*, Upstream Engineering Conference, Washington, D.C., September 22–23, 1936.

The Siltation Problem

Closely related to the objective of reducing the speed of water runoff from watersheds and maintaining an optimum flow of usable water is the problem of reducing siltation. Man cannot eliminate the forces of nature which create sedimentation nor can he stop siltation. Watershed control can reduce the amount of soil carried away by precipitation and minimize the harmful effects. The need for such a reduction in siltation is imperative. Elephant Butte Reservoir in New Mexico has lost 16 per cent of its capacity in twenty-five years; Guernsey Reservoir on the North Platte River has lost 21 per cent in twelve years; and the Cucharas Reservoir in Colorado has lost 35 per cent in twenty-six years.[31] It is estimated that Hoover Dam will lose 10 per cent of its reservoir capacity in fifty years.[32]

Damage from sedimentation and siltation is not limited to reservoir areas. The Forest Service has estimated that the total flood and sediment damages amount to at least $250,000,000 annually.[33] Agricultural lands (including irrigation works) and urban areas are subject to damage. Sedimentation and siltation can be reduced by programs in three major directions: [34]

1. Forest and range management.
2. Conservation farming.
3. Impounding structures.

The reduction of sedimentation is a problem of land management throughout a watershed. Erosion-control practices are generally preferable to other methods of reducing sediment damage because they remove the basic cause of the damage and benefit both the areas of erosion and the areas of sedimentation.[35] Although

[31] Victor A. Koelzer and Luna B. Leopold, "Science Against Silt," *Reclamation Era*, XXXIII, No. 2 (February, 1948).

[32] E. W. Lane and J. R. Riter, "The Life of Hoover Dam," *Reclamation Era*, XXXIV, No. 4 (April, 1948).

[33] Carl B. Brown, "Damages Resulting from Uncontrolled Runoff and Sedimentation," *Journal of Soil and Water Conservation*, III, No. 1 (January, 1948), 21–23.

[34] See Reed W. Bailey, *op. cit.*; T. B. Chambers, "Conservation Farming Reduces Runoff and Siltation"; Thomas Maddox, Jr., "Retarding and Impounding Structures Aid Control of Runoff and Siltation," all in *Journal of Soil and Water Conservation*, III, No. 1 (January, 1948).

[35] Stafford C. Happ, Gordon Rittenhouse, and G. C. Dobson, *Some Principles of Accelerated Stream and Valley Sedimentation*, U.S. Department of Agriculture Technical Bulletin 695, May, 1940, p. 102.

sheet erosion is usually considered to be more damaging to uplands, gullying is more serious as a source of harmful sediment because runoff from gullies delivers its sediment load directly to the valley bottoms or to the stream channels.[36] Once in the stream channel, the detrimental effect of sediment on water-storage facilities is inevitable. Only a relatively small proportion of the total load passes through the reservoirs.[37] It has been estimated that "as a result of silting alone 21 per cent of the Nation's water-supply reservoirs will have a useful life of less than 50 years, another 25 per cent will last 50 to 100 years, whereas only 54 per cent will provide enough storage to suffice for present requirements (not the estimated future needs) 100 years hence." [38]

The economic and social significance of sedimentation is great. The reduced production and income on the lands where erosion occurs may be largely local losses so far as the immediate effects are concerned. But the broader effects on the quantity and quality of water available are far-reaching. There may be no available reservoir site to replace one which has lost its usefulness; at best there may be a site which is inferior in its capacity and effectiveness and, proportionally, more expensive. In some instances, it may be possible to lengthen the useful life of a reservoir by adding to the height of the dam or by costly methods of removing sediment from the reservoir area. These are, however, extremely unsatisfactory and expensive methods which are concerned with the *results* of the problem rather than the *roots* of the problem.

The Need for Coordinated Action

Comprehensive river basin development transcends state lines. That is implied in the definition of a river basin. Rivers are not influenced by man-made political boundaries. The problems involved in river basin development are usually interstate in character and so are the benefits which may be expected to accrue. The preceding sections of this chapter have described the basic relationship

[36] *Ibid.*, p. 76.

[37] Gunnar M. Brune, *Rates of Sediment Production in Midwestern United States*, U.S. Department of Agriculture, Soil Conservation Service, SCS–TP–65, Milwaukee, Wis., December, 1948, p. 13.

[38] Carl B. Brown, *The Control of Reservoir Silting*, U.S. Department of Agriculture Miscellaneous Publication 521 (Washington, D.C.: Government Printing Office, 1943), p. 20.

between the watershed as the source of a water supply which is satisfactory in quantity, quality, and timeliness of flow and the interests of the downstream users. It seems obvious that a development program must be coordinated if maximum benefits are to be realized.

To say that unified resource development is essential does not reflect a political or social philosophy. Such a conclusion is arrived at starting with something so simple as the basic phenomenon of water running downhill. The fundamental considerations involved in the need for coordinated development of land and water resources are physical in character. The average citizen becomes so enmeshed in the controversy concerning political organization and administration of resource development that he or she never gains an understanding of the physical problem of river basin development.

Resource development policy in the United States is emerging from the concrete-pouring and dam-building stage of emphasis. Development programs have a long way to go, however, before they represent a truly coordinated approach to the resource problem. This point is emphasized by the fact that eight dollars are being spent on main-stream development in the Missouri Basin for each dollar spent on watershed protection.[39] This situation is difficult to overcome as long as the general public and its elected representatives are impressed by reports of the tons of concrete poured and yards of dirt moved in building dams while failing to recognize the significance of the more unspectacular programs of land treatment. Placing the emphasis on such evidences of bigness as huge dams is a characteristic of the American mind which often fails to recognize that the total effect of small efforts may be more important and certainly more crucial in the solution of the problem at hand.

Experience in two areas of Oklahoma during a season of excessive rainfall illustrates the results of land treatment. One area involves the Washita Flood Control Project of the Soil Conservation Service. The other area is the location of two large flood control dams constructed by the Army Engineers. The first area received 15.58 inches of rainfall within 36 hours while the second area received 9.79

[39] *Bozeman Daily Chronicle* (Montana), February 13, 1952; reporting a speech by Gladwin E. Young before the Mississippi Valley Association meeting at St. Louis, Missouri.

inches of precipitation within 48 hours. In the second area, water poured over the two flood control dams while, in the conservation area, water was delivered to the stream in such a way that it did not go out of its banks until a mile below the last dam and after it had picked up the runoff from a mile of widening and untreated valley.[40] In other words, the conservation area controlled water runoff in such a manner that it did a better job of handling almost 60 per cent more precipitation falling in three-fourths of the time period involved in the area of big dams.

Resource development by federal agencies is under way on most of the major rivers of the United States. Large sums of money have been spent and additional appropriations are made annually for the building of structures on the main streams. To date, no comparable program of watershed development has been authorized. The U.S. Department of Agriculture has proposed such a program for the Missouri Basin,[41] and is preparing similar reports for other major river basins. In the meantime, construction goes forward on main-stream structures without provision for watershed protection of the large public investment involved.

In addition to the physical relationships between land and water which make unified development imperative, the multiple use of resources adds further emphasis to the problem. Cooke wrote:

> From a social standpoint the river itself becomes a vastly important, multiple-purpose agency which . . . must be nurtured in manifold and unaccustomed ways while the dam becomes simply an important servitor of the river. In fact, it may be said that our present concentration on the dam and the beneficent power it creates has blurred the picture and kept us from realizing all that is involved in total river use as affecting regional development.[42]

Just as the physical features of resource development force a recognition of the need for unified effort, so does multiple use of resources indicate the same conclusion regarding economic and social problems. How well does the river basin serve as a unit for attacking this latter phase of the total problem? The river basin is

[40] Elmer T. Peterson, "Dams Didn't Do It, Absorption Beats Containment," *The Land*, IX, No. 2 (Summer, 1950), 225–31.

[41] House of Representatives Document 373, 81st Cong., 1st sess., *Missouri River Basin Agricultural Program* (Washington, D.C.: Government Printing Office, 1949).

[42] Morris L. Cooke, "Multiple Purpose Rivers," *Journal of the Franklin Institute*, CCXXXVII, No. 4 (April, 1944), 251–64.

admirably suited to the solving of the physical problems of resource development. When coupled with an adequate land program, it is the ideal tool for the conservation, control, and use of water. The river basin is not entirely satisfactory, however, as an area for the study and solution of economic and social problems. Economic regions are likely to be somewhat different from the physical regions of drainage basins. In areas where water transportation on the river system is of major importance, the economic region may conform closely to the river basin. In other areas where institutional factors are dominant, the geographic area of economic and social problems may be varied and, seemingly, bear little relation to the drainage basin.

River basins of the magnitude of the Missouri, the Columbia, and the Colorado are so large that the social scientist can recognize regional boundaries as the physical scientist determines them, on the basis of drainage, and not handicap his approach to the problem to any significant extent. The outlining of economic and social regions which do not conform to major river basins may be more important where smaller drainage basins are a physical characteristic. In New England, for example, the physical problems of conservation, control, and use of resources will be worked out on the basis of small drainage basins which are part of a larger economic and social region. To some extent, the physical features of the resource development programs in large river basins are a summing up of programs for smaller drainage basins.[43] The reverse of the situation in which economic and social problems go beyond the physical confines of a river basin should be noted. A study of man's relation to resources in the middle section of the Rio Grande Valley revealed that the problems of this delineated portion of the river basin could not be separated out because "evidences of a critical breakdown in the physical relationships of the entire watershed require an over-all and coordinated approach and solution."[44]

An understanding of the physical relationship involved in river basin development and the implications of economic and social

[43] Roy E. Huffman, "Economics of Irrigation Development," A paper presented before the Canadian Agricultural Economics Society at the Thirty-first Annual Meeting of the Agricultural Institute of Canada, Winnipeg, Manitoba, June 27, 1951.

[44] Allan G. Harper, Andrew R. Cordova, and Kalervo Oberg, *Man and Resources in the Middle Rio Grande Valley* (Albuquerque, N.M.: University of New Mexico Press, 1943), p. 87.

regions does not eliminate or obscure the problem of unified administration of resource development. Placing primary emphasis on the fundamental characteristics of a watershed, however, does clear away the fog of prejudiced argument and make obvious the fact that *some type* of unified administration is needed. The problem is well stated in the following excerpt:

> . . . In nature the function of river and land are one. Under generally prevailing administrative practice, however, they are divided up among specialized agencies, separate in policy and direction. The inter-relation of valley and river and the coordinate character of the river's various potential uses should be reflected in a corresponding unity of managerial direction—a single coordinating agency, not several separate ones. The relation of such a semiautonomous agency to, and its servicing by, the Federal Government is among the unsolved problems of public administration.[45]

Alternatives in Regional Administration

There are few public issues which are the target of more shallow thinking and more biased discussion than the administration of resource development. Most politicians and most organizations cannot come within gunshot of the subject of resource development without making statements and passing resolutions for or against the pattern of interagency committees and for or against valley authorities. It would be refreshing indeed to hear a politician or an organization suggest an objective study of the basic problems of development to the end that the best possible means might be found of carrying on unified administration within the framework of democratic action. Limiting consideration to two alternatives is not an intelligent approach. It may be likened to the situation where a man is handed a can of black paint and a can of white paint and is told that he can paint only black or white. Obviously, he can paint many shades of gray depending on how he mixes the paints. By the same token, there is a great middle ground of alternatives for administration of resource development. The administrative organization can be anything that is acceptable and can be brought into existence through legislation or other public action.

[45] Cooke, *op. cit.*

Robinson has suggested three types of administration for interstate streams. They are:[46]

1. Turning over the administration of interstate streams to the federal government. This would result in organizations of the general type of the Tennessee Valley Authority.

2. Placing the administration of interstate streams under the authority of autonomous agencies created by interstate compacts. This approach results in the projection of certain state powers upward to a superstate organization.

3. A pooling of the governmental and administrative resources of individual states, complemented by the advice and counsel of federal agencies, under an informal, purely voluntary, functional arrangement. This might be somewhat on the order of the interagency committees now functioning in several western river basins, although the existing interagency committees are dominated by the federal agencies with the states in an advisory capacity.

The Tennessee Valley Authority, as the only regional organization of its kind, has been the subject of much praise and censure.[47] There is much to be learned from the TVA experience. Other sections of the nation should be able to profit greatly through study of the accomplishments and the shortcomings of the TVA. The viewpoint, however, that the TVA type of organization can be transplanted intact to other river basins is just as dangerous and unrealistic as the attitude that TVA is a socialistic endeavor not worthy of consideration in formulating administrative organizations for other river basins. All available experience and information should be utilized in tailoring an administrative organization to a particular river basin. It is extremely unlikely that any two river basins would require exactly the same type of organization.[48] Con-

[46] David W. Robinson, "Voluntary Regionalism in the Control of Water Resources," *The Annals of the American Academy of Political and Social Science,* CCVII (January, 1940), 116–23.

[47] W. V. Howard, *Authority in TVA Land* (Kansas City, Mo.: Frank Glenn Publishing Co., Inc., 1948); David E. Lilienthal, *TVA, Democracy on the March* (New York: Harper & Bros., 1944); C. Herman Pritchett, *The Tennessee Valley Authority* (Chapel Hill, N.C.: University of North Carolina Press, 1943); Joseph S. Ransmeier, *The Tennessee Valley Authority* (Nashville, Tenn.: Vanderbilt University Press, 1942); Philip Selznick, *TVA and the Grass Roots* (Berkeley, Calif.: University of California Press, 1949).

[48] Albert N. Williams, *The Water and the Power* (New York: Duell, Sloan & Pearce, Inc., 1951). This study illustrates the great diversity of resources and problems in five major river basins of the West.

gress has consistently turned down proposals to extend the valley authority type of organization to other major river basins of the nation. The peak of sentiment favorable to the valley authority concept may have been reached in 1945 when an omnibus authority bill was introduced in Congress proposing to divide the nation into nine authorities as outlined in Figure 2.

Use of interstate compacts to achieve coordinated resource development is receiving increasing attention from individuals and groups who recognize that some improvement is necessary over the present methods of coordination. How useful the compact approach can be in achieving coordination is largely a matter of opinion. Interstate compacts have been fairly successful as a means of dividing or allotting resources or solving other problems of a more or less static nature. It remains for the future to show whether or not interstate compacts can provide a satisfactory basis for developmental organizations or for organizations functioning as day-to-day administrators of a river system after the development program has been completed. Such application of the compact concept is being undertaken. For example, the New England Interstate Flood Control Committee has drafted an interstate compact and the states of the Ohio Valley have instituted an Ohio River Sanitation Compact.[49] The dynamic nature of a developed and operating river system is indicated by this description:

> In Central Valley this means that a master water dispatcher must know the future needs of crops for water for days and even weeks in advance, so he can release proper amounts of water that will arrive on time from one or more reservoirs situated perhaps hundreds of miles away. He must anticipate the melting of snowpacks and the run-off of flash floods to keep them harmless and prevent waste of their waters. He must study irregularities of precipitation, to know in which ones among the two-score reservoirs he should retain water longest, and from which he ought to release it first. Only by such fine operation can a complex project serving many purposes produce the greatest possible benefit year in and year out. Only if a single agency has control over every part of the project is it possible to achieve fine operation. Two agencies, or three, cannot do it, no matter how competent each may be individually.[50]

[49] Lynton K. Caldwell, "Interstate Cooperation in River Basin Development," *Iowa Law Review*, XXXIII, No. 2 (January, 1947).

[50] Paul S. Taylor, "Central Valley Project: Water and Land," *The Western Political Quarterly*, II, No. 2 (June, 1949), 229–54.

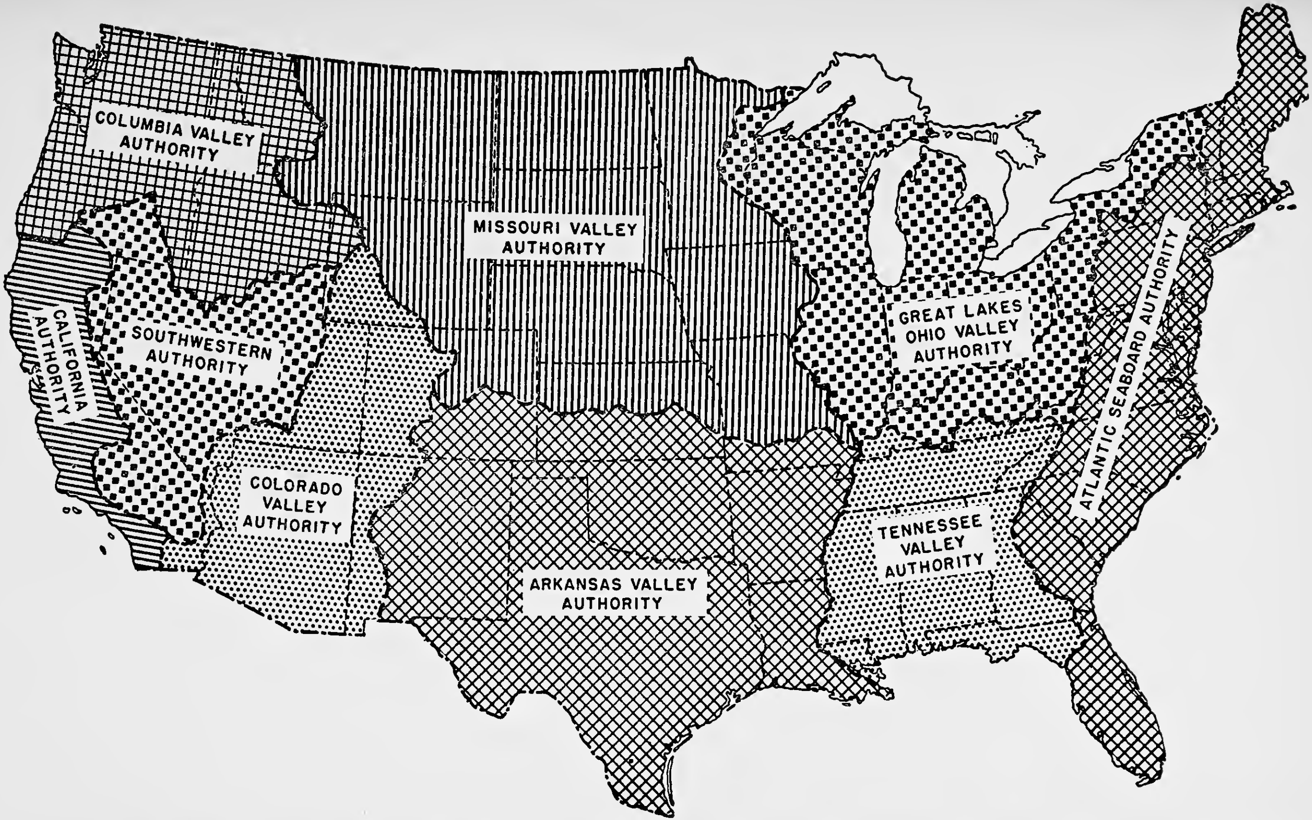

FIGURE 2. Map Showing Division of United States into Authority Zones as Proposed in Omnibus Authority Bill. (Rankin Bill, House of Representatives Document 1824, 79th Cong., 1st sess.)

There are several interagency river basin committees in existence including the Arkansas-White-Red, the Colorado, the Columbia, and the Missouri. The interagency committees are made up of representatives of the major federal agencies working in a river basin plus representatives of the states making up the river basin. These committees are voluntary organizations without legal status and without power to enforce any decision which may be made. As members of an interagency river basin committee, the various federal agencies give up none of their statutory sovereignty. The committee can function only in an advisory capacity. It is probable that most of the coordination accomplished by the various interagency committees has been the result of the constant "encouragement" provided by the reintroduction of valley authority legislation in every session of Congress. Such a threat had provided the original impetus for the first meager moves toward coordination in the Missouri Basin.[51]

In addition to the interagency committees in specific river basins, there is a federal interagency river basin committee, and a number of states have interagency councils. There is, however, no administrative relationship among the interagency committees at the three levels.

It appears that there are two parts to the problem of achieving coordinated administration of resource development. First, there is the problem of coordinating the activities of the various federal agencies. Second, there is the problem of coordinating activities at the federal, state, and local levels.

Much has been written regarding the lack of coordination among federal agencies in resource development. Some writers have indicated an extreme amount of competition among agencies.[52] The shift from single-purpose resource development to comprehensive multiple-purpose stream planning has done much to expand the conflict. John Moses, late governor of North Dakota, has been quoted as follows regarding the activities of the Army Engineers and the Bureau of Reclamation in the Missouri Basin:

> It was inevitable that these two agencies of the Federal Government would come into conflict over the use of the waters of the

[51] Joseph Kinsey Howard, "Golden River," *Harper's Magazine*, May, 1945.
[52] Leslie A. Miller, "The Battle That Squanders Millions," *Saturday Evening Post*, May 14, 1949.

> Upper Missouri River. Here were two separate Federal agencies working under entirely different basic laws, responsible to separate committees of Congress, and serving conflicting purposes; one seeking to store flood waters to prevent flood damage and to reserve the water for later use in aid of downstream navigation, the other seeking to store the same flood waters higher up the streams and tributaries for later use upon the land for production of crops and the closer settlement of farm homes. To a certain extent one might say that the basic concept by the people living along the more than 2000 mile course of the Missouri River from its headwaters to its mouth, concerning the highest use of its water, is just as divergent as are the views of these two Federal agencies.[53]

A great many federal agencies have regional organizations to carry on a specific function such as the Federal Reserve System, the Bureau of the Census, and the Weather Bureau. It has been pointed out that "Though they may touch regional problems, they do so from the strictly Federal point of view, under the assumption that a given Federal operation has exactly the same result in one region as in another." [54] This type of regional organization is designed primarily for convenience in housekeeping functions and contributes little to the integrated approach necessary to resource development. Moreover, the geographic areas covered by the regional organizations are different for almost every agency, which further complicates the problem of coordination among government agencies.

The problem of coordination among federal agencies engaged in resource development would be largely eliminated by congressional enactment of the recommendations of the Commission on Organization of the Executive Branch of the Government (Hoover Commission).[55] Consolidation of federal resource agencies into a Department of Natural Resources could, in itself, achieve considerable coordination. With respect to river basin development, all phases of a comprehensive approach would then be on the same basis of administrative organization and geographical area.

[53] Rufus Terral, *The Missouri Valley* (New Haven, Conn.: Yale University Press, 1947), p. 201.

[54] Donald Davidson, "Political Regionalism and Administrative Regionalism," *The Annals of the American Academy of Political and Social Science*, CCVII (January, 1940), 138–43.

[55] The Commission on Organization of the Executive Branch of the Government, Task Force Reports, Appendix K, Appendix L, Appendix Q (Washington, D.C.: Government Printing Office, January, 1949).

Coordination of local and state efforts in the field of resource development with those of the federal government involves a variety of problems. In this writer's opinion, local and state effort should play a larger part in resource development. Such an expansion of nonfederal activity can be both public and private. There are numerous examples of local approaches to resource development. The Wisconsin River, often called "the hardest working river in the country" has been the scene of an integrated program of power development through the Wisconsin Valley Improvement Company. This organization has nine stockholders, each one an independent company. The Improvement Company is a forty-person organization ruling a river 430 miles in length.[56]

Two examples of public action at the local level are found in Ohio where the Muskingum Watershed Conservancy District has eliminated floods, increased the productivity of agricultural and forest lands, and created valuable recreational facilities,[57] and in Pennsylvania where the Brandywine Valley Association has controlled erosion and cleaned up a polluted stream.[58]

The problem of coordinating resource development and increasing local participation is not limited to the United States. Australia is faced with much the same problem in connection with development of the Murray Valley. Holmes has written:

> A fully planned economy (that is to say, a planned turning of the environment to account by which opportunities are provided for human welfare) is false and dangerous when it ignores man's fundamental allegiance to that which is small, intimate and thoroughly understandable. Man's whole sense of social well-being is wrapped up in his feeling that he "fits." . . . This is something which the nineteenth century industrial civilization and two wars have done much to destroy. . . . The history of mankind, we believe, clearly demonstrates that the fundamental machinery of government starts with the people. . . .[59]

One of the most serious shortcomings of the present programs of resource development is the lack of understanding and support

[56] "One Less River to Boss," *Electrical World,* August 14, 1948.

[57] James B. Craig, "The Miracle of Muskingum," *American Forests,* LV, No. 7 (July, 1949).

[58] James B. Craig, "The Second Battle of the Brandywine," *American Forests,* LV, No. 10 (October, 1949).

[59] J. MacDonald Holmes, *The Murray Valley* (Sydney, N.S.W.: Angus & Robertson, Ltd., 1948), pp. 67–68.

on the part of the general public. The general lack of agreement on how development should be carried on may be largely a result of the extreme confusion of the average citizen regarding the objectives of river basin development. A greater degree of local participation in development programs would serve to strengthen the role of the states in river basin development. A broader basis of participation might provide the necessary support for the organization by each state of a legally constituted resource commission or board which would be the coordinating agency working with federal agencies. A possible middle ground of action to facilitate coordination of resource development would include three steps. They are:

1. Consolidation of federal agencies concerned with resource development in order to eliminate duplication and competition.
2. Organization of a strong resources commission or board in each state which could act both in the state and on interstate matters.
3. Cooperation among the states, possibly through interstate compacts, in order that the states might function jointly with the federal agencies on interstate streams.

There should be no compromise in a program to achieve the *physical development* of river basins in accordance with basic land-water relationships. There is, however, considerable latitude in the type of *administrative organization* which can effectuate physical development. The administrative organization should be such as to achieve the maximum degree of coordinated effort within a political framework acceptable to the people of the basin.[60]

River Basin Accounting

It has been noted earlier in this chapter that the generation of hydroelectric power has been a part of some federal irrigation projects for a great many years. Power revenues from these facilities

[60] The foregoing discussion of regional administration was written in February, 1952. Since that time, individuals and organizations concerned with the problem have evidenced an increasing willingness to abandon extreme positions and seek a compromise solution. Specifically, there has been growing support of the interstate compact method, including the establishment of regional or river basin commissions to serve as administrative units. This progress toward greater coordination in resource development is associated with a more widespread understanding of the limitations of present attempts to secure unified development. It may also reflect an increasing maturity on the part of the citizenry with respect to the total problem of resource development.

have helped to repay the construction costs of such multiple-purpose projects. The power facilities are presumed to repay their investment cost with interest whereas the irrigation investment is repaid without interest. The "interest component" in federal power development has become one of the most controversial aspects of public water policy. Actually, the interest on the investment in power facilities has been used to help repay irrigation construction costs rather than being returned to the national treasury. This, of course, constitutes a subsidy of irrigation by the taxpayers of the nation. To the extent that other power revenues are used to repay irrigation costs, the power users of the region are subsidizing irrigation development. Such a procedure would prevent a lowering of power rates in line with the amount of the power revenues used to repay irrigation costs.

The income-producing ability of hydroelectric power has brought plans for making the fullest possible use of the revenue to aid the development of other water uses, particularly irrigation. This is especially true of the Columbia Basin with its great power potential and where the "basin account" has been widely advocated. The basin account would make the interest component as well as other power revenues from all power facilities in a river basin available for paying irrigation costs anywhere in the basin to the extent that they could not be repaid by the water users. In the case of the Columbia Basin, the interest component is estimated to be sufficient to take care of any needed irrigation subsidy.[61] In the Missouri River Basin, the 1944 Flood Control Act has been interpreted as combining all water uses into the "Missouri Basin Project." [62]

Obviously, the basin account would discriminate in favor of irrigation development in river basins with great hydroelectric power resources. Specifically, it would make possible in one river basin (such as the Columbia) the development of irrigated lands which were inferior to lands in another river basin where the lesser power resources did not provide a sufficient subsidy. Rather than aiding the expansion of public irrigation development throughout the West, the basin account system might tend to limit it to regions possessing great quantities of hydroelectric power.

[61] President's Water Resources Policy Commission, Report of, Vol. II: *Ten Rivers in America's Future* (Washington, D.C.: Government Printing Office, 1950), p. 42.

[62] *Ibid.*, p. 250.

CHAPTER 11

The Public Interest in Water Resources

Water is a scarce good in many places. Scarcity of a good relative to demand makes it a part of the economic structure. Areas which, heretofore, have found it necessary to give little attention to the water problem are finding that the water resource is the limiting factor in their economic development. As a good becomes more scarce and as the control and use of that good takes on increasing importance, it becomes of greater concern to many people; both those who are affected directly and those who are aware only of the indirect consequences. From such a situation, there develops what is commonly called "the public interest" in how the water problem is handled.

Failure to recognize the public interest in water use in many areas is due to the prevalence of a certain misconception concerning the economic nature of water. In spite of the growing pressure on the water resource and consequent rising prices—greater scarcity of any good relative to demand implies a higher price—there is a tendency to rank water third only to air and sunshine as something which should be available as a free good. This concept of water as a free good makes difficult the growth of an interest on the part of the public at a pace comparable with the acceleration in the water problem itself. This is particularly true in the more humid areas. The average inhabitant of New York City probably never thought beyond the faucet or fountain as far as water is concerned until the shortage of the recent past.

In most of the western United States, there is a more widespread recognition of the economic importance of water. The irrigation farmer who pays for water as he does for any other factor of production, and sometimes finds it in short supply, is well aware of his interest in water. The residents of those western towns and cities surrounded by arid and semiarid lands make the availability of water a part of their daily thinking. Los Angeles is the outstand-

ing example of a major city which has found it necessary to spend large sums of money to bring water long distances for domestic and industrial uses.[1] Even in those areas where the economic importance of water is widely recognized, however, pressures may be such that it is extremely difficult to secure a consideration of water problems in the light of "the public interest."

What Is the Public Interest?

"The public" is a vague sort of concept. It may be, in our everyday use of the term, almost any group in our society which can make itself heard. Is capacity to make noise a measure of the public interest? Just where does something pass from the classification of private interest into the realm of public concern? These are important questions because due to the complex nature of our society there are few if any public policy judgments where the conflict between the private and the public does not enter. John Dewey has provided a clear and reasonably usable framework for defining "the public." He presented the following criteria for defining "the public" and thus for differentiating it from the private: [2]

> 1. The public consists of all those who are affected by the indirect consequences of transactions to such an extent that it gives them a common interest and it is deemed necessary to have those consequences systematically cared for by some sort of control whether by inhibition or by promotion.
> 2. The consequences concern so many people that a person cannot readily prefigure how they are to be affected and it is necessary to establish certain dikes and channels so that actions are confined within prescribed limits and have moderately predictable consequences.
> 3. The public implies a definite organization which can act through its officers who are representatives of a public and shared interest and which requires the drawing of lines between the too close and intimate and the too remote and disconnected.
> 4. Such an organization, if it moves on to become a political unit, is an example of the public becoming the state and is, in fact, the basis of government itself.

[1] Remi A. Nadeau, *The Water Seekers* (New York: Doubleday & Co., Inc., 1950).

[2] John Dewey, *The Public and Its Problems* (Chicago: Gateway Books, 1946). Not quoted verbatim but summarized from various parts of the book.

Dewey further illustrated what he means by "the public" when he wrote: "The decline of isolationism is evidence that there is developing the sense that relations between nations are taking on the properties that constitute a public and hence call for some sort of political organization." [3] The importance of the public at the community level is emphasized as follows: "Whatever the future may have in store, one thing is certain. Unless local communal life can be restored the public cannot adequately resolve its most urgent problem: to find and identify itself." [4]

The public, then, is more easily identified at the community level but it may be large or small in relation to various problems. It may or may not be related to some political, legal, or incorporated unit of government but it must be organized. It may be comprised of the residents of an unincorporated village working out their problems, or it may be at the county, state, regional, national, or international level.

Individuals and groups trying to differentiate between the public and the private may argue that Dewey's formulation is of no help because it fails to provide an exact yardstick for making the distinction. They may argue that to hinge the question on the consequences of transactions is pointless because all human actions have consequences which affect others. Whether or not all transactions do have consequences affecting others than those immediately concerned is really unimportant in this context. The important thing is whether the consequences are of enough significance to create an interest on the part of a public. Viewed in this manner, Dewey's formulation is sufficient in the case of public policy decisions on the practical level. The extreme ramifications of the definition may be of little more than academic concern.

Technological developments, changing social values, and greater political maturity are constantly shifting the boundary between the public and the private. That is why Dewey's search for the public, and his concept of how the public emerges, bears such an important relationship to the formulation of public policy. The public interest may be judged to be different next year from this year or last year. And in no phase of public policy is such a possibility more evident than in connection with water resources.

[3] *Ibid.*, p. v of Introduction.
[4] *Ibid.*, p. 216.

The Public vs. the Private

As society becomes more complex and as the pressure of population on resources becomes significant in certain areas, the conflict between the public and the private interest becomes ever sharper. It must be resolved repeatedly. Penn has noted:

> . . . the individual in search of his own best interests does not always perform in the public interest. This is the critical point for most people, particularly economists. You can either define yourself right out of the problem and spend your time on the further elaboration of the economics of the firm, in which case you just refuse to acknowledge a problem, or you can become disillusioned with the whole system. Many things can happen to you then.
>
> Of course, we should do neither. Rather, we should accept the economic philosophy of the public and the most refined mathematical analysis of the economist. Then in those instances where the public interest appears in jeopardy we should attempt to see what factors are causing the trouble. . . .[5]

The protests of private interest against policies and programs carried on in the public interest are usually a result of detrimental effects on private profits. Penn has further pointed out:

> An individual should not be condemned for acting to maximize his profits. Where his interests coincide reasonably well with the public interest no problem exists. In fact, government action in this area has no place. When an individual's quest for maximum profit leads him to do things not in the public interest, (1) we should be very careful that we have correctly determined the public interest and not some individual's statement as to what the public interest ought to be, (2) we should look to the reasons for the existence of the disparity and try to make adjustments which will bring the two interests together. Adjustments of this kind will in many instances increase the individual's profit possibilities and no investment of public resources is necessary. . . .[6]

It was noted earlier that, when the consequences of private transactions become significant to others than those directly involved, the public will express itself and emerge as some sort of an organization. One of the most difficult questions in these days when society is dominated by pressure groups is that of differentiating

[5] Raymond J. Penn, "Public Interest in Private Land," in *Land Problems and Policies*, edited by J. F. Timmons and W. G. Murray (Ames, Iowa: Iowa State College Press, 1950), p. 222.

[6] *Ibid.*, p. 223.

between organizations which represent private interests and those which fall into the classification of "the public." It is obvious that certain organizations are representing private interests. Other organizations may be just as clearly expressing the public interest. Many of the multitude of organizations, however, are difficult to classify. Examples of actual situations may help to clarify this point.

In 1949, the Bureau of Reclamation of the United States Department of the Interior announced that it was considering a plan to raise the level of a lake on the Madison River, a tributary of the Missouri, in the high country of southwestern Montana. The development was to provide additional water storage for the irrigation of new acreage downstream. An immediate result was the organization of something called the Madison Valley Protective Association which protested the proposed development. Was this the voice of the public expressing its interest? The fact that all officers of the Association were residents of Salt Lake City, about four hundred miles to the south, and all were owners of commercial recreational facilities on the lake made the protest appear to be that of an organized private interest. What was the public interest in this matter? The people who will settle on the irrigation project, if it is built, have an interest in the matter. But they are future settlers and nobody knows yet who they will be. The question of whether the proposed irrigation development was justified received little consideration although it was an important part of the total problem.

This is not to imply that what happened around the lake shore was devoid of public interest. There are a great many people who are repeated visitors to the lake for recreational purposes. The likelihood of those people with a common interest in the lake becoming organized into an audible public is remote because of the geographic factor—they are residents of a number of states. Does this mean that the Madison Valley Protective Association, which on the surface appeared to be an organized private interest, was really representing the public interest in an indirect fashion? This is the same question with which Commons was concerned when he wrote: "The question always is not, *what* is a private purpose over against a public purpose? But, is the private purpose also a public purpose or merely a private purpose?" [7]

[7] John R. Commons, *Legal Foundations of Capitalism* (New York: The Macmillan Co., 1939), p. 326.

The same question can be raised regarding many better-known and more permanent organizations concerned with water resources. The most important organization in the promotion of increased irrigation in the western United States is the National Reclamation Association. It is associated with state associations in all of the seventeen western states. Membership in the national association and in the state organizations is made up primarily of the representatives of chambers of commerce, agricultural development departments of railroads, real estate agencies, and promotional groups in general. There are few bona fide irrigation farmers among the membership of any of the reclamation associations. This is a major weakness of these organizations, a weakness which many of the leaders recognize. Is the National Reclamation Association expressing the public interest as it makes legislative recommendations to Congress?

Another organization of this type is the National Rivers and Harbors Congress which is the spokesman for the navigation interests in the United States. Membership in this organization is heavily weighted with representatives of the construction industry and allied businesses—people whose future depends on the type of work involved in river and harbor improvements. Few members are to be found whose interest is in the results of such public improvements—shipping on the inland waterways. Is it in the public interest to spend large sums of public funds to develop navigation channels on such streams as the Missouri River and the Upper Mississippi? It appears quite significant that the annual appropriation for river and harbor work by the Army Engineers is consistently referred to as the "pork barrel" appropriation.

The Public vs. the State

An instance has been discussed where the Bureau of Reclamation proposed to raise the level of a lake and an organization was formed to protest the plan. This is only one instance of many in which proposals of government agencies have been opposed, indeed, are being opposed every day. The federal government has attained a vast size. How accurately do the policies and programs of the various agencies reflect the public interest? The electorate has demonstrated in several federal elections (an expression of the

public at the national level) its approval of a policy of resource conservation. Congress has translated that approval into action programs through appropriations. Do objections to certain programs and proposals indicate a conflict between government bureaus and the public interest? Indeed, one may wonder if the size and relationships of some government agencies have become such that they are more representative of certain organized private interests than of the public interest. Administrators develop a personal interest in the perpetuation and expansion of the agencies which they head. Agencies are closely allied with certain pressure groups. Outstanding examples are the Bureau of Reclamation and the National Reclamation Association; the Army Engineers and the National Rivers and Harbors Congress; and the Soil Conservation Service and the Association of Soil Conservation District Directors.

On the other hand, is it not possible that a government agency may represent the public interest in some cases where the public has not emerged for one reason or another? An example is the proposal of a few years ago to provide a large amount of cheap storage for irrigation by raising the level of Yellowstone Lake in Yellowstone National Park by placing a small dam three or four feet in height across the outlet. The public having an interest in Yellowstone National Park is widely scattered geographically. More than a million people visit the nation's best-known park each year, and they come from every state and also many foreign countries. The National Park Service lodged a strong protest against the proposal to alter in any way the natural beauties of Yellowstone National Park and the idea of changing the level of the lake was dropped. In this case, two government agencies were opposing each other. Which one was expressing the true interest of the public?

The real issue, then, in the concept of the public vs. the state is whether some government programs are contrary to the public interest or whether they merely reflect a conflict between a public at one level of social organization and a public at another level of social organization, or, possibly, two publics at the same level of social organization. If a government program is not in the public interest, it implies that the government agencies are so far removed as to have lost contact with the public or that policy making is being unduly influenced by certain private interests. It is also possible that the state may be protecting the long-run public interest against a

short-run viewpoint prompted by economic pressures or lack of knowledge. This point will be given further consideration in another section.

The Public vs. the Public

A third area of conflict may arise between opposing viewpoints both of which may represent a public—either two publics at the same level or two publics at different levels. At least, neither side in the disagreement seems to represent any private interest. Perhaps the best-known conflict at two different levels is the state rights controversy. Policies drawn on a national basis, and assumed to represent the public interest at that level, are often opposed as being inimical to the interest of the public at the state level.

The relatively recent recognition and attempted solution of natural resource problems on a regional basis has resulted in a continuing dispute between the public at the state level and what is argued to be the regional public interest. Some people will contend that much of the defense of the state position is by organized private interests who recognize that they can wield a greater influence in state government than at the national level. It is difficult for the public interest at the regional level to be adequately expressed because the state has never emerged to correspond with natural regions and the public is not accustomed to organize and express itself on a regional basis. Although the public may be large or small and have no direct connection with an organized state, there is a significant tendency for the public interest to be expressed in close conformity to the state.

The continuing controversy between the proponents and opponents of valley authorities as the means of carrying on regional (river basin) development has, thus far, been resolved in the direction of maintaining inviolate the public interest at the state level, favoring certain other public interests and a great many private interests, and giving lip service to the public interest at the regional and national level. Merriam has written: "Finally in a democratic system, the rivalry sometimes arising between public and private organizations may not readily be reconciled. . . . There are parties and pressure groups and ambitious aspirants for more and more power in these various groups. But they must all pledge allegiance

to the common good, in theory if not in practice, and the superior claims of the community they profess to serve."[8] In much of the current water resource development in the United States, the problem of the larger public interest (regional and national) has never been faced honestly.

It is difficult to suggest instances of conflict between two public interests at the same level of social organization. However, it is entirely possible for two interests to be in conflict on the same level where both exhibit more of the characteristics of public than of private interests. An example would be the public (the less athletic portion) wanting to provide automobile access to an isolated lake being opposed by the public (the more vigorous portion) wanting to retain the primitive aspects of the lake and keep it accessible by hiking trail only.

Long-Run vs. Short-Run Public Interest

There may be major conflicts in the public interest in relation to time. A public may advocate a certain course of action which is in conflict with the more immediate interests of another public. We have, then, a conflict between long-run and short-run public interest. A public which promotes the long-run interest is likely to be small in size and, in many cases, to be labeled as impractical and visionary. The longer the view into the future, the more judgments that must be made and the greater the scope of the judgments. The fact that the public which is concerned with the long-run interest is small in size and obliged to make a larger proportion of value judgments makes it difficult to secure recognition of the long-run over the short-run interest.

An example involving major questions of public water resource policy can be cited. For many years, development of the St. Lawrence Seaway has been one of the most consistently proposed fields for public action. New York City has fought such a seaway because it would lessen to some extent New York's importance as a seaport. At the same time the vast midland area of the nation, which stands to gain most from the extension of ocean traffic to the Great Lakes, has never presented any sort of unified support of the proposed development. The public interest in the Midwest and the Northern

[8] Charles E. Merriam, *Public and Private Government* (New Haven, Conn.: Yale University Press, 1944), p. 18.

Great Plains has been concentrated on problems closer to home and of a more immediate nature. The St. Lawrence Seaway is probably one of the two or three most important water resource policy questions in the United States (and Canada) because of its relation to future economic development and to national security. It might be possible to demonstrate that the seaway would mean as much to the future of the Northern Great Plains as the Missouri Basin Development which largely coincides with the Plains area itself. The Northern Great Plains is a producer of bulky and heavy agricultural products; therefore, bringing ocean transportation almost to the edge of the area would have great significance in the long run. Admittedly, it would be difficult to convince people in the Missouri Basin that a development in another region might mean something to them. This illustrates the fact that the long-run public interest in resource problems is often sacrificed to a more vociferous short-run public interest which has as its most important consideration the question of where the public funds are to be spent.

Canadian governmental policy may result in United States action with regard to the proposed seaway after so many years. If the United States does take action, it will be because the Canadian action has converted the problem to one of immediate interest. Canada has said that, if the United States doesn't cooperate in the immediate future. Canada will build the project as a strictly Canadian effort. This means that American shipping will have to pay toll charges imposed by Canada. So a situation arises where the American public interest is recognizable by many consistent opponents of the seaway proposal.

The state is often the key to adequate recognition of the long-run public interest. As a continuing entity, the state is in a position to take a longer view than the private entrepreneur and groups with a more restricted view of the public interest. In fact, economic factors may make it impossible for anyone except the state to take a sufficiently long-run viewpoint. This is particularly true of the conservation of resources. Exploitive development and use of resources may be such that only the state is in a position to represent a viewpoint consistent with the long-run public interest.

The four concepts of the public vs. the private, the public vs. the state, the public vs. the public, and the long-run vs. the short-run public interest illustrate the difficulty of ascertaining many times

and under many different circumstances what the public interest is in the use of a scarce resource like water.

Institutional Factors and the Public Interest

The institutional framework of society may protect the public interest or, as institutions are outgrown, they may be a hindrance to action in the public interest. Constitutional law and court decisions are examples. Frankfurter has pointed out that Jefferson believed the Constitution of the United States would be changed through time because ". . . laws and institutions must go hand in hand with the progress of the human mind. As that becomes more developed, more enlightened, as new discoveries are made, new truths disclosed, and manners and opinions change with the change of circumstances, institutions must advance also, and keep pace with the times." [9]

The water resource has been the object of widespread public interest in most societies. Throughout recorded history, the public interest has been dominant where scarcity of water was a major factor. This has been indicated in an earlier chapter with respect to the Code of Hammurabi. Considerations of the public interest are evident in both the doctrine of riparian water rights and the doctrine of appropriation in the United States. It is especially evident in the beneficial-use concept in the appropriation doctrine.

The difficulty of drawing a line between public and private interest in western water law was illustrated by Commons as follows:

> But the public need not be all of the public, it may be a particular individual. The Supreme Court declared that a single farmer in Utah might exercise the power of eminent domain to carry enough water for his use alone. But he was granted that power not as an individual—he was granted it on account of the expected public purpose he would serve by augmenting the national resources. He was granted it as a class of individuals, although he happened to be the only member of the class.
>
> The public is not any particular individual, it is a classification of activities in the body politic deemed to be of value to the rest of the public, rather than a classification of individuals. Anybody who comes along "indifferently" and gets himself into a position where he might perform that class of activity, is the public. His private inter-

[9] Felix Frankfurter, *The Public and Its Government* (New Haven, Conn.: Yale University Press, 1930), p. 53.

ests, when he gets in that position, are deemed identical with the public interest.[10]

In a lecture entitled "The Ecology of Government," Gaus has pointed out the necessity of relating government functions to the environment.[11] Much attention has been given to the problem of tenure in land. Increased attention must be given to the limitations imposed on water resource development by the existing pattern of water tenure. The Colorado River Compact attempted to provide for the "equitable apportionment of the waters of the Colorado River system, and also to provide machinery and methods for continuous supervision and adaptations of policy to changing conditions." [12] The public has a major interest in the growth of institutions that contribute to the orderly processes of society but have sufficient flexibility to permit desirable change.

Penn has listed five techniques which the public uses to protect its interest in private lands. They are also applicable to the public interest in water resources.

1. Changes in institutions
2. Investment of public funds as inducements
3. Land use regulations
4. Acquisition of ownership
5. Research and education [13]

The factor of situs is important in the problem of public interest in the use of water. Control of a particular geographic location may give exclusive right to the use of water for a given purpose. Ownership of the only available hydroelectric dam site on a stream would be an example of this. It has been said: "The proposition that our great industrial institutions are instrumentalities of the community cuts across this preconceived category of 'publicness' and 'privateness.' " [14] The public interest in private water power developments is maintained, of course, through public utility regulations.

[10] By permission from *Legal Foundations of Capitalism*, by John R. Commons, p. 328. Copyright, 1939, The Macmillan Co., New York.

[11] John Merriman Gaus, *Reflections on Public Administration* (University, Ala.: University of Alabama Press, 1947), p. 3.

[12] Frankfurter, *op. cit.*, p. 71.

[13] Penn, *op. cit.*, p. 229.

[14] William J. Donovan, "Is the Interest of the Public Consistent with the Interest of the Utilities?" *Proceedings of the Academy of Political Science*, XIV, No. 1 (May, 1930), 167–76.

Private property in water, then, often conflicts with the public interest and may hinder "progress." The holders of property rights in water, like the owners of land, have a tendency to believe that such rights are God-given. All proposals for change are denounced as attempts at regimentation and attacks on freedom. This reaction is fairly common among most holders of private property when the society which gave the property rights in the first place makes any attempt to modify, restrict, or rearrange them in the public interest.

Public Interest and Public Policy

The social scientist working with problems of public policy is always confronted with the question of the extent of the public interest. Is the social scientist working for a particular state justified in limiting his concept of the public interest to the state in which he is employed? Is he obligated to do so as a public servant of that state? Indeed, do many public employees unconsciously identify the public interest with the interest of the state? The social scientist's conception of his role will have considerable effect upon his judgment of the public interest.

The fact that change is the dominant characteristic of our social structure would seem to make it evident that the public interest cannot be determined by formula or some other fixed measuring device. Where does this leave us with regard to a basis for the formulation of public policy? The factor of change means that what is deemed to be in the public interest today may not be in the public interest in five, fifty, or one hundred years. Public policy recommendations (prescriptions for public action) are not of a nature to be acceptable indefinitely. All public policy needs to be modified periodically in the light of change; in some cases, it may need to be completely revised. Note changes made through amendments to our federal and state constitutions in order that public policy might be changed. In some instances, a changed interpretation of the constitution permits the desired shift in public policy. Penn noted that arriving at the public interest is a continuous process of public-policy and program formulation; he writes: "It is the process that counts. If the means are faulty, the objective will not be satisfying even if reached." [15]

[15] Penn, *op. cit.*, p. 225.

Recognizing that continuing change is the major complicating factor in ascertaining the public interest and in making recommendations for public action, where does the social scientist begin? The situation emphasizes the need for investigation to bring all available facts to bear on the problem. Inasmuch as the human element cannot be eliminated from problems in the social sciences, it must be recognized that value judgments are of major importance in prescriptions for public action. Not only is the human factor an element in the problem itself but there is also individual reaction involved among the social scientists making value judgments. Personal bias cannot be completely eliminated unless a race of test-tube social scientists who all think alike develops.

Man will continue to look for "two-plus-two-equals-four" answers to social problems. In most cases, however, he will find that value judgments will be necessary to supplement the incomplete yardsticks he may develop. This is particularly true of the distinction between the public and the private. The public is a changing thing wherever it is found. What constitutes the public and the public interest is something for determination in the case of each problem. The social scientist is chasing rainbows if he expects to eliminate value judgments. Roscoe Pound has written:

> Even the crudest or most blundering or most capricious adjustments of relations or ordering of conduct has behind it some canon of valuing conflicting and overlapping interests. It may be merely keeping the peace. It may be preserving the social status quo. It may be promoting a maximum of free individual self-assertion. It may be enforcing the self interest of a dominant social or economic class or of one seeking to become dominant. It may be maintaining and furthering the power of established political organization.[16]

Unfortunately, the social scientist is never able to judge the success or failure of his prescriptions for public action relative to alternative possibilities. He has no "check plot" as does the physical scientist. In most cases, his recommendations can suggest several alternative courses of action but only one can be carried out. In some cases, there is no clear-cut decision made between or among alternatives. Many people in policy making positions are undoubtedly willing to ignore the issue, for as Commons wrote:

[16] Roscoe Pound, *Social Control Through Law* (New Haven, Conn.: Yale University Press, 1942).

"Public policy," said the English jurist, "is a very unruly horse, and when once you get astride of it you never know where it will carry you." It is, indeed, unruly for it lives in the feelings rather than logic, the field of values rather than mathematics. Every individual, every judge, and every official or government has a different set of habits and emotions from every other individual, and the resulting emotions of value are the very center of individuality. Quite correctly here, as elsewhere, the courts endeavor to escape this unruly horse by seeking some external rule fixed in the nature of things that does not change with changing valuations. But try as they may they cannot escape valuing consciously or unconsciously, by logic or habit, the relative importance of the human interests at stake. Every transaction is weighed at every point according to what is deemed to be a public purpose.[17]

[17] By permission from *Legal Foundations of Capitalism*, by John R. Commons, p. 325. Copyright, 1939, The Macmillan Co., New York.

CHAPTER 12

Evaluation of Water Resource Development

Public expenditures for water resource development should not be made without analysis of the probable costs and benefits. The President's Water Resources Policy Commission notes that evaluation has been part of resource development since the first public project.[1] The problem of evaluation has evolved from comparatively simple procedures to methods of great complication. The budgeting procedure for determining the value of irrigation water is typical of the method by which the benefits of single-purpose resource development may be assessed as they apply to direct beneficiaries. As public resource development becomes more and more concerned with high-cost projects, it appears imperative that all benefits and detriments be included in the analysis if expenditures are to be justified.

Projects and Programs

Public irrigation development, and resource development generally, has been formulated, evaluated, and authorized on the basis of *projects* until very recently. With the advent of the river basin system of resource development, a broader basis of evaluation and authorization has come to the fore. *Programs* of development for entire river basins have replaced projects as the unit of planning and operation, while projects are constituent parts of such programs.[2] The President's Water Resources Policy Commission stated:

[1] President's Water Resources Policy Commission, Report of, Vol. I: *A Water Policy for the American People* (Washington, D.C.: Government Printing Office, 1950), p. 55.

[2] The Bureau of Reclamation uses the term "project" for what the Commission calls a "program" and refers to projects as "units" of a basin project. It may have been the hope of the Bureau that, if the term "project" was generally applied to basin development, it would carry with it the connotation that the word "project" now has for the man in the street. In view of the fact that the Bureau terminology is not used generally by the public, this writer will use the word "project" in its traditional meaning in irrigation development and apply the word "program" to basin development.

> . . . the selection of projects and combinations of functions depends on an evaluation which views the program as a whole in all its complexities. . . . Project evaluation, if it is to give useful answers, must consider all the various facets of a basin development program. These include the technical, the financial, the economic, and the public aspects. In a similar manner, program evaluation must consider all features related to national objectives.[3]

The concept of resource development in terms of projects and programs establishes a two-stage pattern of evaluation. A project should be evaluated from the standpoint of its place in and contribution to a program of resource development. A program should be evaluated from the standpoint of its place in and contribution to national resource development. Presumably, no project would be evaluated or authorized apart from its significance as a constituent part of a program. Actually, such a two-stage pattern of evaluation would be difficult, if not impossible, to adhere to in view of local promotional pressures and political considerations. Some projects will be authorized without reference to their place in a program of resource development. To the extent that the concept of resource programs is realized, the problem of evaluation becomes much broader than in the case of project by project consideration. Whereas project evaluation is limited in most cases to financial feasibility with direct beneficiaries expected to pay costs in full, program evaluation is concerned with economic evaluation including public values. This is particularly significant when it is remembered that a resource program is synonymous with river basin development, including use of all constituent resources in the basin.

Market and Extramarket Values

There is great variation in the terminology used to distinguish between the benefits from resource development which can be measured in monetary terms and those benefits to which the dollar sign cannot be applied. Perhaps the most widely used terms are tangible and intangible benefits. The President's Water Resources Policy Commission used "intangibles" as if it were synonymous with public or social values.[4] The validity of such terminology is

[3] President's Water Resources Policy Commission, Report of, *op. cit.*, Vol. I, p. 58.

[4] *Ibid.*, p. 56.

questionable in view of the fact that intangible benefits are not limited to the general public. Private beneficiaries may also profit from resource values which cannot be assigned a monetary measure. An example would be the more pleasant living conditions made possible on irrigated farms by trees, flowers, and lawn around the home, which would be impossible without irrigation water.

Another commonly used distinction between public and private values from resource development is in terms of direct and indirect benefits with the indirect classification representing public or social values. This distinction can be misleading in view of the fact that private benefits can be both direct and indirect, as can public benefits, if direct beneficiaries are taken to be the primary users of the resources. Kelso added refinement to this terminology by relating direct benefits to microeconomic analysis—gains and losses to individual firms—and indirect values to macroeconomic analysis—gains and losses to the economy as a whole. Factors not measurable in monetary terms are referred to here as intangibles.[5]

Use of the term "intangible" gives the impression that there are certain benefits which cannot be seen, when, in reality, they may be most obvious but are not measurable in monetary terms within the existing framework of economic theory and economic analysis. At present, they fall outside the realm of goods and services for which the market structure establishes monetary values. They may be brought within the market structure at some time in the future. For that reason, this writer proposes to classify the benefits of resource development as having either *market value* or *extramarket value*, the latter referring to those benefits currently outside the existing market structure.[6]

Benefits having market value may be either direct or indirect. The irrigation farmer is, obviously, a direct beneficiary of irrigation development, while the main-street businessman in the nearby town is an indirect beneficiary whose gains are measurable in monetary terms. Benefits having extramarket value may be either direct or indirect, also. Most such benefits, however, tend to be indirect.

[5] M. M. Kelso, "Economic Criteria for Conservation and Development of Public Lands," *Proceedings of the Western Farm Economics Association*, Davis, Calif., June 23–25, 1948, pp. 85–92.

[6] See S. V. Ciriacy-Wantrup, *Resource Conservation; Economics and Policies* (Berkeley: University of California Press, 1952), pp. 85, 238–48, for use of this terminology.

There are two possible approaches to the problem of measuring those benefits of resource development having extramarket value. First, there is the possibility of assigning a monetary measure to them and, in effect, shifting them to the group of benefits having market value. Second, for those benefits not subject to monetary measure, there is the possibility of establishing a nonmonetary system of measurement. Primary emphasis has been on the first approach. This is to be expected in view of the fact that we live in a dollar-conscious society and that Congress insists on evaluation of resource projects in monetary terms. Recreational benefits are most prominent among the extramarket values for which monetary measures are being sought. The approach commonly used is to calculate the amount of money the public spends in pursuit of a particular type of recreation. An Illinois report suggests: "The tangible cost of a sport is indicative of its intangible value. The money spent by the public to hunt and fish is a good measure of the public desire for hunting and fishing, just as the money spent for the man-made sports is a good measure of the public desire for these recreational activities." [7] This study showed, for example, that Illinois hunters spent an average of about $7.25 for each duck they killed and bagged. Another study found the cost of catching a pound of largemouth bass amounted to $8.66 in 1949.[8] Figures such as these are then used to calculate the recreational benefits of streams and lakes.

Certain negative benefits (detriments or costs) may have market values while others may be of the extramarket type. A report of the Public Health Service pointed out: "The impairment of water quality by pollution represents damages that may include both tangible and intangible values. In many instances, the intangible will far exceed tangible values. It is not possible to place a monetary value on public welfare and well-being and, in some cases on public health, although these factors assume tremendous importance in our daily lives." [9] Listed as detrimental results of water pollution

[7] Frank C. Bellrose and Clair T. Rollings, *Wildlife and Fishery Values of Bottom Land Lakes in Illinois*, Natural History Survey, Biological Notes 21, Urbana, Ill., June, 1949.

[8] George W. Bennett and Leonard Durham, *Cost of Bass Fishing at Ridge Lake, Coles County, Illinois*, Natural History Survey, Biological Notes 23, Urbana, Ill., February, 1951.

[9] Federal Security Agency, Public Health Service, *A Cooperative State-Federal Report on Water Pollution, Missouri River Drainage Basin*, Water Pollution Series 3, 1951, p. 27.

are (1) impaired public water supplies, (2) impaired water quality for industrial uses, (3) contaminated water for irrigation, (4) damage to fish and wildlife, (5) destruction of recreational areas, and (6) decrease in property values.

Reservoir construction is another source of negative benefits. Property owners are reimbursed for property inundated, but a study in Missouri revealed many associated factors which were costly to the individuals involved. People did not receive adequate information on which to base personal plans. Condemnation procedures were time consuming and costly with payment for land often delayed. People were not compensated for disturbance, moving expense, and cost of getting re-established. Public costs were involved, too, as the reservoir made necessary a drastic reorganization of school districts and road systems.[10]

There are a great many values associated with resource development for which no satisfactory method of monetary measurement have been devised, and some of them appear to defy such measurement under any circumstances. The dollar value of using a lake for irrigation or generation of hydroelectric power or as a source of municipal water can be determined with considerable certainty. At the same time, scenic values may be destroyed or seriously impaired by creation of a fluctuating water level. Who is to say that the prospective dollar values outweigh the satisfactions gained by the individuals who do nothing more than sit on a hill and gaze across the lake before its natural beauties are disturbed?

Some economists argue that evaluation of resource development should be limited to those benefits having market value with extramarket values being ignored. There are two reasons advanced in support of this viewpoint: (1) inclusion of extramarket values complicates what might otherwise be a neat economic analysis; and (2) extramarket values are relatively insignificant in the total benefits from resource development. There can be no doubt regarding the accuracy of the first point, but the second may be open to question if a society with increasing amounts of leisure should put a growing emphasis on esthetic values.

[10] Missouri Division of Resources and Development, *Local Effects of the Wappapello Reservoir, Wayne County, Missouri, with Suggestions for Lessening Undesirable Effects of Reservoirs*, Jefferson City, Mo., February, 1950.

The Benefits-Costs Analysis

Evaluation of resource development is made through benefits-costs analysis. Some variation of this analytical procedure is used by all federal agencies in justifying projects. The most comprehensive treatment of benefits-costs analysis is contained in the report of the Subcommittee on Benefits and Costs of the Federal Inter-Agency River Basin Committee.[11] This Subcommittee was organized to work out a system of economic analysis for resource development which could provide a uniform basis of evaluation and eliminate the differences in procedures used by the various agencies. It is obvious that a common basis of project analysis is essential if projects are to be brought together for evaluation in terms of river basin programs and national resource policy.

The Subcommittee stated that the economic analysis should include procedures which will permit taking into account the following considerations:

> 1. The service to be performed by a project will have value only to the extent that a need or demand for that service is to be expected. . . .
>
> 2. The most effective use of economic resources is made if they are utilized in such a way that the amount by which benefits exceeds costs is at a maximum rather than in such a way as to produce a maximum benefit-cost ratio. . . .
>
> 3. The project or any separable segment or increment thereof selected to accomplish a given purpose should be more economical than any other actual or potential available means, public or private, of accomplishing that specific purpose which would be displaced or precluded from development if the project is undertaken. . . .
>
> 4. From an economic standpoint the order in which a number of economically justified projects should be undertaken should be based on their relative efficiency in use of economic resources.[12]

The procedure for benefits-costs analysis presented by the Subcommittee is concerned with market values:

> Goods and services which fulfill human needs and desires and which are limited in supply have economic value. Any goods and

[11] Federal Inter-Agency River Basin Committee, *Proposed Practices for Economic Analysis of River Basin Projects,* Washington, D.C., May, 1950.

[12] *Ibid.,* p. 5.

services for which there is no need or demand have no economic value. In order for the effects of a project to have economic value in terms of benefits and costs it is necessary that there be a need or demand for the goods and services produced by or used for the project.

The most practicable measure of the relative desirability of goods and services for meeting the various needs and demands which exist is the market price in dollars. . . . To the extent that project effects can be assigned an actual or estimated market value, they may be defined as benefits and costs in terms of the market value in dollars of the increases or decreases that are expected to result if a project is undertaken.[13]

The Subcommittee does not ignore the existence of benefits and costs having extramarket values. The group wrote, "These intangible effects need to be described with care and should not be overlooked or minimized, merely because they do not yield to dollar evaluation."[14] And again, "Project effects which cannot be given monetary values should be recognized and considered apart from the analysis of monetary values. If intangibles are considered sufficiently significant to influence either project formulation or selection, it is important that intangible benefits and intangible costs be considered to a comparable extent."[15]

If the extramarket benefits and costs are to enter into evaluation procedures, it seems obvious that a uniform system of analysis is fully as essential in their case as in the measurement of market values. No one has yet suggested analytical procedures which can assure that, if they are applied at the project level, they will be comparable when brought together at the program level. The Subcommittee said only, "Projects should be evaluated in monetary terms to the maximum extent practicable. If market prices are not available, estimated or derived values may be appropriate in some cases. In other cases, intangible effects will need to be considered on a qualitative basis."[16]

Although the President's Water Resources Policy Commission placed great emphasis on nonmonetary values, it likewise failed to bring forth a procedure for measuring extramarket values. Commenting on the report of the Subcommittee on Benefits and Costs, the Commission wrote:

[13] *Ibid.*, pp. 7–8.
[14] *Ibid.*, p. 26.
[15] *Ibid.*, p. 27.
[16] *Ibid.*, pp. 27–28.

> The commission agrees as to the difficulties and complexities involved in the measuring of secondary benefits, as defined in the report, in dollar terms. But many projects will have their major effect on the broad development of our social economy. It will, therefore, be contrary to the public interest to place principal reliance in project analysis on primary benefits, which may often be private in character.[17]

The question, of course, is whether or not it is possible to devise a yardstick, to be used alongside of the dollar, which will be sufficiently acceptable and free of bias as to produce evaluations that are comparable when brought together. It is doubtful in view of the fact that the judgment plays such an important role in the appraisal of nonmonetary values. Kelso suggested, "Every single unit area model of a development plan that shows a reasonable ratio of benefits to costs from among all models tested for that area should be submitted to a central federal government agency." [18] The job of such a central agency would include the balancing against each other of the extramarket values involved in competing projects. The President's Water Resources Policy Commission adopted this line of thought when it recommended the creation of a Board of Review in the executive branch of the federal government composed of members "with a broad understanding of the economic and social as well as technical aspects of regional development." [19]

Returning to the evaluation of benefits and costs having market value, consideration should be given to the manner of expressing the results of analysis as a "benefit-cost ratio." If the benefits of a project are expected to be twice the costs, that project would have a benefit-cost ratio of 2 to 1. Any project having a ratio in excess of 1 to 1 would be economically feasible and any project with a ratio of less than 1 to 1 would not be economically feasible. Water resource development should be formulated and evaluated in such a way that the excess of benefits over costs is maximized rather than that the largest possible benefit-cost ratio is achieved. In choosing between and among alternative projects and programs, the emphasis must be on net benefits if the maximum in market values is to

[17] President's Water Resources Policy Commission, Report of, *op. cit.*, Vol. I, p. 56.

[18] Kelso, *op. cit.*

[19] President's Water Resources Policy Commission, Report of, *op. cit.*, Vol. I, p. 49.

accrue as a result of expenditures for the development of water resources.

Multiple-purpose development is the crux of the problem of formulating alternative projects and programs to maximize net benefits. This is illustrated by the hypothetical example in Table 7.

TABLE 7
HYPOTHETICAL EXAMPLE OF THE MAXIMIZATION OF BENEFITS OVER COSTS IN A PROJECT OR PROGRAM

Number of Water Uses	Benefits		Costs		Excess of Benefits over Costs	Benefit-Cost Ratio
	Total	Additional	Total	Additional		
1	250		100		150	2.50–1.00
2	600	350	400	300	200	1.50–1.00
3	800	200	550	150	250	1.45–1.00
4	1,000	200	700	150	300	1.42–1.00
5	1,100	100	800	100	300	1.37–1.00
6	1,200	100	925	125	275	1.29–1.00

In this example, the over-all benefit-cost ratio will be the largest with a single-purpose development but the total net benefits will be at a minimum. Additional uses should be included in the project or program as long as each use shows a benefit-cost ratio of at least 1 to 1. On the basis of market values alone, development should be carried out involving five uses of water. The fifth use might not be included, however, although it has a benefit-cost ratio of 1 to 1. It neither adds to nor subtracts from the total net benefits. Extramarket costs may be the determining factor in whether or not the fifth use is included. If inclusion of the fifth use creates certain non-monetary social costs, such a marginal use may be left out. It is here that extramarket values, in addition to the economic demand for the particular water use, are so important in the final evaluation.

On the other hand, the project or program in Table 7 may be formulated to include the sixth water use if the extramarket values thus created are judged important enough, although the additional costs exceed the additional benefits and the excess of benefits over costs is, of course, reduced. A case in point might be the production of a strategic material essential to national security. Let us assume that the hypothetical project or program is an alternative to another project or program which can produce a maximum of 285 in net benefits. Developed on the basis of either four or five uses of water,

our hypothetical example is the superior alternative with net benefits of 300. If the sixth use is included, the project or program will show net benefits of only 275, which makes it an inferior undertaking unless the extramarket values are given due weight in making the choice between the two alternatives. Such decisions should be made only at the highest level because only there can the national interest be determined.

The benefits-cost analysis is, of course, similar to the marginal analysis of equating marginal costs and marginal returns. There is a major difference, however, in its application here as compared with its application to the individual firm. The private enterpreneur is concerned primarily with his individual costs and returns and not with public values. It is true, of course, that the private entrepreneur may also go beyond the marginal point to maximize extramarket values of a private nature. In the long run, however, competition will force him to operate at or near the point where marginal costs equal marginal returns. Should the public stop at the marginal point where net benefits are maximized? Why not extend a project or program to an over-all benefit-cost ratio of 1 to 1?

It should be recognized that, concerned as it is with market values only, the benefit-cost analysis is little different from determinations of financial feasibility. Each phase of a project or program having a benefit-cost ratio of at least 1 to 1 will "pay off" in monetary terms, although some of the measurable benefits may be public as well as private. Considered in that framework, to carry a project or program development beyond the marginal point, and include water uses having a benefit-cost ratio of less than 1 to 1, means that such uses would be subsidized by uses having a ratio greater than 1 to 1. The argument that net returns from the generation of hydroelectric power should not be used to pay for other phases of multiple-purpose development is based on this concept. The benefit-cost method of analysis is designed to meet congressional insistence on evaluation of water resource development in monetary terms. As such, it is a procedural concept and should not be construed as placing a limit on the level at which public development of water resources may be justified.

When extramarket gains and losses are considered, it becomes obvious that projects and programs may be justified at some other level than the marginal point in benefit-cost analysis. This was indi-

cated in a limited manner in the discussion of variations from the point of maximum net benefits in the hypothetical example in Table 7. Obviously, if extramarket values are judged to be of sufficient importance, public expenditures for water resource development can be carried to the point where the over-all benefit-cost ratio for a project or program is 1 to 1, or *it can be carried beyond that point* inasmuch as the benefit-cost ratio includes only market values. This again emphasizes the need for uniform evaluation of extramarket values in order that sound choices may be made among alternative projects to be included in programs and among alternative programs to be included in national water development goals.

Procedures in Benefits-Costs Analysis

Several writers on the subject of the evaluation of resource development have emphasized that the analysis should be carried on as a consideration of *with* and *without* situations with respect to the proposed project rather than on the basis of a *before* and *after* analysis. A comparison of the situation existing before a project is built and that expected to prevail after the project has been developed will ignore the advancement that may be expected to be made in the same time period without public resource development. A with and without analysis compares the situation expected to prevail when the project is completed and the situation which could have been expected to develop without the project but with the same conditions of economic progress, technology, institutional change, and price levels.[20]

An observation made by the Subcommittee of the Federal Inter-Agency River Basin Committee is pertinent to the with and without analysis. It is as follows:

> Any economic effects which, although they will occur in a chain of events stemming from a project, may also be expected to occur if the project is not undertaken, are not attributable to the project insofar as measuring the efficiency of use of economic resources for project purposes is concerned. Therefore, in identifying and evaluating the benefits and costs attributable to a project for purposes of

[20] See M. M. Regan and E. C. Weitzell, "Economic Evaluation of Soil and Water Conservation Measures and Programs," *Journal of Farm Economics*, XXIX, No. 4, Part I (November, 1947), 1275–94, for discussion of the with and without analysis.

economic analysis, the possibility that the goods and services diverted for project purposes would be useful for other purposes in the absence of the project must be taken into account. Similarly, the beneficial effects that would result if goods and services were used for other than project purposes must be taken into account.[21]

The benefits arising from resource development are classified as primary, secondary, and tertiary. The benefits-costs analysis is concerned only with primary and secondary benefits. Using an irrigation project as an example, the Subcommittee suggests the following terminology for identifying benefits and costs:

Projects costs are the value of the goods and services (land, labor, and materials) used for the establishment, maintenance, and operation of the project including allowance for induced adverse effects, whether compensated for or not. On the irrigation project, the project costs would be the costs of making irrigation water available to the farmer.

Associated costs are the value of the goods and services needed, over and above those included in the cost of the project itself, to make the immediate products or services of the project available for use or sale. The farmer's costs of producing wheat (other than any charge for the irrigation water) would be associated costs.

Primary benefits are the value of the immediate products or services resulting from the measures for which project costs and associated costs were incurred. In the irrigation project illustration, the primary benefits are the value of the wheat produced by the farmer.

Secondary costs are the value of any goods and services (other than those covered by project and associated costs) which are used as a result of the project. These include the costs of further processing the immediate products or services of the project and any other costs, over and above project and associated costs, stemming from or induced by the project. In the irrigation project example, the costs of transporting the wheat, elevator and milling costs, bakery costs, and the costs of distribution to the consumer would be secondary costs.

Secondary benefits are the values added over and above the value of the immediate products or services of the project as a result of activities stemming from or induced by the project. In the irriga-

[21] Federal Inter-Agency River Basin Committee, *op. cit.*, p. 9.

tion project example, the value of the bread over and above the value of its wheat content would be a secondary benefit.[22]

Using the above definitions, the Subcommittee translated benefits and costs into *net benefits attributable to the project* as follows:

> . . . the primary benefits attributable to the project are the total primary benefits minus the benefits foregone through use of the associated resources for project purposes rather than for other purposes. . . . the benefits foregone are, in the usual case, assumed to be equal to the market value (i.e., the cost) of the goods and services used. Therefore, except when adjustment is necessary for unusual conditions . . . the primary benefits to a project are equal to the total primary benefits less associated costs.
>
> . . . No secondary benefits are attributable to the project unless it can be shown that there is an increase in such benefits as a result of the project as compared with conditions expected in the absence of the project. . . . net secondary benefits can accrue, for example, under the following types of conditions:
>
> 1. When the primary benefits attributable to the project exceed the project costs, the project, in effect, produces a surplus of goods and services as compared with the amount of production of goods and services to be expected in the absence of the project. . . . therefore, in the absence of the project, the surplus could usually be made available to secondary activities only at an increased market price. The fact that secondary activities can obtain the project surplus without an increase in market price is a secondary benefit which is attributable to the project. The amount attributable to the project is the difference between the market value of the project surplus and the cost of producing an equivalent surplus by some other means in the absence of the project. . . .
>
> 2. The second general condition under which net secondary benefits may be creditable to a project arises when the goods or services used in activities stemming from or induced by the project would have a lower use value (i.e., would have been unused or underutilized) in the uses to be expected in the absence of the project. In such cases, the net increase in such value is a net secondary benefit attributable to the project. . . .[23]

The above procedure results in net project benefits being the sum of the primary benefits attributable to the project plus any net secondary benefits. Or put in another way, project benefits must be net of all costs other than those designated as project costs. The benefits-costs ratio is the ratio of these project benefits to the project costs.

[22] *Ibid.*, pp. 8–9.

[23] *Ibid.*, pp. 10–11.

The Subcommittee presented a more restricted concept of secondary benefits than is popularly adhered to with respect to irrigation projects. In considering the effect of new irrigation developments, it is generally held that the activities of the businessmen, professionals, and service people in a town dependent on irrigation are benefits creditable to the irrigation project. From the local point of view, such activities can definitely be credited to the existence of the irrigation project. Without irrigation, all or most main-street economic activity would be nonexistent and, in fact, the town might not be there. The Subcommittee, however, takes a national point of view in its consideration of secondary benefits and secondary costs. Viewed in relation to the national economy, it is argued that, if the project did not exist, the business, professional, and service activities would be carried on in some other place. In other words, these activities do not constitute a net addition to national income. The only secondary benefits creditable to the irrigation project, from the national point of view, are the additional values added by manufacturing or processing of the produce and services from the irrigated lands.

Evaluation of a proposed project from the national point of view is, of course, the correct approach in the consideration of alternative opportunities for the expenditure of federal funds on water resource development. Essentially the same business, professional, and service activities would be associated with the expenditure of public funds wherever it might be made. Only the production of goods and services from the facilities provided by the irrigation development and the addition of values to those goods and services through manufacturing or processing can be credited as benefits attributable to the irrigation project. The concept of secondary benefits presented by the Subcommittee is not contradictory to the more widely accepted view of the relation of main-street business activity to the irrigation project. The two concepts are based on different points of view—one national, the other local.

Complications in Benefits-Costs Analysis

The evaluation of resources development is complicated by the fact that the benefits and costs are not incurred as of a given instant. The major part of the project costs will occur at the time of con-

struction, but the benefits are expected to be realized over a period of time and some costs may not even appear until some time has elapsed. This situation gives rise to three important problems: (1) the level of prices to be used in computing benefits and costs, (2) the interest and discount rates to be used in adjusting to a comparable basis the values of benefits and costs that accrue at varying times, and (3) the length of the time-period to be used in analysis.

The Subcommittee of the Federal Inter-Agency River Basin Committee points out that from a temporal point of view costs incurred and benefits accrued in the operation of projects fall into three general classes:

1. Investment costs, which are usually incurred at the outset of the project.
2. Operation, maintenance, and replacement costs, which occur at various rates and times throughout the life of the project.
3. Benefits, which can be assumed to accrue throughout the life of the project at uniform or varying rates.[24]

The costs of construction should be computed on the basis of prices prevailing at the time of project analysis if such costs are to be incurred shortly thereafter. If the development of the project is to be some time later, then the construction costs should be estimated on the basis of prices expected at the proposed time of construction. It is difficult for the economists evaluating projects to know when a specific project may be built. Time schedules for development may be worked out, but the fact remains that Congress makes the final determination of the time of development when it appropriates the funds. It is probable that most construction costs are estimated on the basis of current prices. In a period of steadily rising prices, such as the past decade, a delay of much length in construction will result in investment costs enough above the original estimate as to constitute a significant part of the much discussed underestimation of the costs of resource development.

Recurring costs associated with operation and maintenance of a project, and the benefits to be realized over the life of the project, pose a more difficult problem regarding the level of prices to be used. After rejecting use of prices for a particular year, the average of prices for a period of years, and the prices current at the time of

[24] *Ibid.*, pp. 17–18.

analysis, the Subcommittee says that "all things considered, the most satisfactory approach would result from using prices estimated as they are expected to be at the time when costs are incurred and benefits received."[25] This statement, of course, is one to which it is difficult to take exception. The problem of arriving at such an estimate of prices as they will be fifty years or more from now is not easy.

Regan and Greenshields took a somewhat different point of view and wrote:

> Forecasts of the dollar prices actually expected to prevail at the time of benefit and cost occurrence are not necessarily essential. It is more important that the projections reflect the relative worth of goods and services under the resource employment conditions expected during the period of installation and operation of the project. With a high average level of resource employment expected to prevail throughout the life of a project, primary emphasis would be on the "real" values of the goods and services as measured by their purchasing power. Under such conditions, proper evaluation of projects requires comparisons of the purchasing power of the goods and services invested with that of the goods and services produced, each measured at time of occurrence.
>
> Emphasis on real values eliminates secular trends in the general price level as a factor in evaluation. The expectation of inflationary price trends should have little or no significance in determining justification from a public viewpoint. With stable levels of resource employment, the expectation of deflationary price trends would also be eliminated from consideration in analyzing economic justification.[26]

The elimination of the effects of inflation and deflation from the evaluation process would be highly desirable. It appears, however, that the same problems are involved in projecting real values as in estimating future price levels. Judgments must be made as to levels of employment and the demand for goods and services expected to prevail, whether projects are evaluated on the basis of money prices or real values. In that connection, the Subcommittee recommends the type of forecast made in a 1948 report of the Department of Agriculture on *Long Range Agricultural Policy* wherein three alternative levels of employment were postulated and there were in-

[25] *Ibid.*, p. 17.

[26] M. M. Regan and E. L. Greenshields, "Benefit-Cost Analysis of Resource Development Programs," *Journal of Farm Economics*, XXXIII, No. 4, Part II (November, 1951), 866–78.

cluded for each a projection of prices, income, and other indicators of economic activity. The Subcommittee voices the opinion that such studies are needed as the basis of benefits-costs analysis.[27]

The interest and discount rates to be used in adjusting benefits and costs for time differences can be determined with less difficulty than future price levels. It is suggested that there are two principal limitations on the use of a single minimum-risk interest rate, such as the government borrowing rate, in discounting and converting all types of benefits and costs to a common basis. They are:

1. The need to take into account residual risks that may be associated with a particular project. The government borrowing rate is relatively risk free because of the security in the taxing power.
2. The need for rates equivalent to those necessary to induce participation by individuals and groups utilizing project services.[28]

The Subcommittee recommended two different interest rates. The first was a rate of 2½ per cent (approximately the current cost of long-term government bonds) for current use in calculating the annual cost of initial federal investments and in the conversion of replacement costs to an annual equivalent basis. The second was a rate of 4 per cent for current use in converting deferred benefits and private costs to an average annual equivalent basis. This rate would approach that needed to induce private investment and participation.[29]

The problem of the length of the period of analysis is handled quite briefly and effectively in the following:

> A number of economic and physical forces limit the economic life of any project. Physical depreciation, obsolescence, changing requirements for project services, and time discount and allowances for risk and uncertainty may limit the present value of future project services. The economic life of a project is determined by the point in time at which the effect of the foregoing factors is to cause the costs of continuing the project to exceed the additional benefits to be expected from continuation. As so used, the economic life is generally less than the physical life of a project and never more than the estimated physical life.
>
> While economic life establishes an upper limit on the period of analysis, it is often convenient and desirable to use a period short of this limit for purposes of economic analysis.[30]

[27] Federal Inter-Agency River Basin Committee, *op. cit.*, p. 18.
[28] *Ibid.*, pp. 22–23. [29] *Ibid.*, pp. 22–23. [30] *Ibid.*, p. 24.

The Allocation of Joint Costs

One of the most controversial points in the evaluation of water resource development has to do with the allocation of joint costs. The building of structures and facilities designed to serve more than one purpose makes inevitable a situation wherein some of the costs involved are not clearly assignable to any one purpose and must be treated as joint costs. Multiple-purpose projects incur two major types of costs similar to the direct costs and overhead costs in private enterprise. The Subcommittee of the Federal Inter-Agency River Basin Committee terms them *separable costs* and *joint costs.* The separable cost for each project purpose is defined as "the difference between the cost of the multiple-purpose project and the cost of the project with the purpose omitted. . . . In effect, separable costs are computed from a series of project cost estimates, each representing the multiple-purpose project with one purpose omitted." Joint costs are defined as "the difference between the cost of the multiple-purpose project as a whole and the total of the separable costs for all project purposes. Joint costs thus represent a residual attributable to all or several purposes." [31]

The allocation of joint costs in water resource development first became a problem of importance with the Boulder Canyon Project Act of 1928 and the Tennessee Valley Authority Act of 1933. Ransmeier poses several questions regarding the allocation of joint costs:

> Why is it that the problem of allocation has arisen only at multiple purpose projects involving revenue-producing objectives? And why is it that the focus of attention in allocation is always upon investment charged to such objectives? Are not the costs of navigation and flood control just as important as those of power (or irrigation)? May not federal funds be as easily squandered upon non-revenue producing purposes as upon revenue producing ones? What is the explanation of this peculiar directional orientation of allocation thinking? We suggest that it rests in the character of the capitalistic economic environment in which multiple purpose enterprise has evolved. This environment is typified by competitive production of goods and services by private enterprise in the quest for profits as measured by the spread between costs and prices. So long as the economic activities of government do not include production of goods and services for sale, they are not usually subjected to the same standards of economy as the market inexorably requires of competitive private enter-

[31] *Ibid.*, p. 54.

> prise. But when government does undertake production in competition for the consumers' dollar with free private enterprise, those who believe in the profit system as a guide for the apportionment of economic resources (regardless of whether or not they favor public operation in a particular area of that system) tend to agree that certain standards of commercial economy should be required of it. Over a "normal" period they argue that government investment should be made only in fields where there is a prospect that revenues will cover costs. Hence the case for allocation.[32]

There are a number of theories as to how joint costs should be allocated among the various purposes of water resource development. Most prominent are two theories: (1) joint costs should be allocated on the basis of the proportion of the facilities used for each purpose; and (2) joint costs should be allocated on the basis of the proportion of the benefits accruing to each purpose. The first theory would allocate the joint costs involved in a reservoir on the basis of the proportion of the water storage used for each purpose. Gertel likens this method of allocation to a department store pricing various items in direct proportion to the floor space occupied by the counters displaying those items. He concludes that the proportionate use-of-capacity method is uneconomic in nature.[33]

The second theory says:

> The distribution of joint costs in proportion to the excess of benefits over separable cost assigns to each purpose an equitable share of project savings. The amount of project benefits used as a basis for allocation of costs to any purpose should not exceed the cost of providing equivalent services for the same area from the most likely economically feasible alternative source available in the area to be served. From such benefits for each purpose, separable costs are deducted to give remaining benefits. Then, joint costs are distributed in proportion to the remaining benefits for each purpose.[34]

Two further points were noted regarding the separable costs-remaining benefits method.

1. The total cost allocated to each purpose (the sum of separable costs and assigned joint cost) should not be less than the cost of including that purpose in the project and should not be more than

[32] Joseph S. Ransmeier, *The Tennessee Valley Authority* (Nashville, Tenn.: Vanderbilt University Press, 1942), pp. 218–19.

[33] Karl Gertel, "Recent Suggestions for Cost Allocation of Multiple-Purpose Projects in the Light of the Public Interest," *Journal of Farm Economics*, XXXIII, No. 1 (February, 1951), 130–34.

[34] Federal Inter-Agency River Basin Committee, *op. cit.*, pp. 54–55.

the benefits of that purpose or the cost of the most economical single-purpose alternative.

2. If the total costs of all purposes should exceed the cost of the multiple-purpose project, there are in effect not joint costs but rather a joint saving, which can be distributed among purposes by reducing separable costs to obtain the allocation to each purpose instead of by adding a portion of joint costs to each separable cost.[35]

The use-of-capacity method is rejected and the costs-remaining benefits method is accepted by most writers on the subject of allocating joint costs. Acceptance of the latter method, however, does not assure its success as a means of allocating joint costs. In a comprehensive study of the Tennessee Valley Authority, Ransmeier concludes that meaningful allocations of joint costs are impossible.[36] Gertel observes:

> A fresh approach to the entire problem may reveal that the wisest solution might be to dispense with cost allocation altogether. . . . Repayment could be achieved by basing rates largely on demand for project services, estimated by field studies, as part of the project planning work. The requirement could be retained that all services pay at least for their separable costs and no more than the costs of a single-purpose project furnishing identical services. Repayment for certain group services such as flood control would have to be undertaken by a group of beneficiaries such as a conservancy district.
>
> Should the total revenues exceed the total costs, the surplus would revert to the Treasury. If it is evident at the planning stage that repayment would be below costs, the project might still be considered, if there are sufficient intangible or widely distributed benefits such as national defense or recreation for which specific repayment is not feasible. . . .[37]

Why Public Expenditures for Resource Development?

The concept of public expenditures to expand and improve the resource base of the nation is not new. Discussing the duties of the sovereign or commonwealth in 1776, Adam Smith saw one of those duties to be

> . . . that of erecting and maintaining those public institutions and those public works, which, though they may be in the highest

[35] *Ibid.*, p. 55.
[36] Ransmeier, *op. cit.*, p. 395.
[37] Gertel, *op. cit.*

degree advantageous to a great society, are, however, of such a nature, that the profit could never repay the expense to any individual or small number of individuals, and which it therefore cannot be expected that any individual or small number of individuals should erect or maintain.[38]

There is much disagreement regarding the type, volume, and direction of public expenditures for resource development. Some segments of American society object to any expenditures of public funds for that purpose. This attitude is generated in many cases by objection to the emphasis on public values which are paid for by all citizens through taxation. Is this a defensible position? Folz has pointed out:

> After 175 years of thinking on the subject of international trade, we have still devised no measurement of the gains of trade. Most economists accept the Reciprocal Trade Agreement program as a good policy, yet we have not been able to measure the economic gains derived from this program. Public education is universally accepted as giving an economic return significantly greater than its costs, but no accurate measurements have been devised to test its economic value. Experimentation and research are generally considered as supplying great economic returns over cost, but again we have no exact measurement of them.[39]

The critics of public programs concerned with resource development are prone to argue that it leads to government control of basic resources and to socialization of the economy. It is contended that private enterprise can and should be given a free hand to develop resources as they are needed. It is argued, also, that our free enterprise economy has advanced without the assistance provided by public development of resources.

This viewpoint shows a considerable lack of knowledge regarding American history or conveniently ignores that historical background. Throughout the history of the United States, the federal government has had as a basic policy the providing of an economic and political climate conducive to the growth of private enterprise while at the same time providing certain protections to the general

[38] Adam Smith, *The Wealth of Nations* (London: George Bell & Sons, Ltd., 1892), II, p. 241.

[39] W. E. Folz, "The Economics of Water Resources Development: A Theoretical Model," A paper presented to the Committee on Water Resources Development of the Western Agricultural Economics Research Council, Ogden, Utah, December 28, 1951.

public against unscrupulous operators. The subsidy provided to American industries by protective tariffs is too often ignored in discussions of this kind. The consuming public pays for such protection (subsidy) in higher prices just as definitely as it pays for public resources programs, through higher taxes. Public resource development often provides competitive advantages to certain industries or phases of industries just as protective tariffs provide competitive advantages.

The federal government has had an important part in the development of the free enterprise system in another way more directly related to the resources themselves. The federal government did much to promote the growth of large businesses but it did not spend public money. It expended what it had the most of—natural resources. It gave millions of acres of land to individuals and corporations. The land grants to railroads were a major incentive (subsidy) in the development of the United States. Other individuals and corporations waxed fat on minerals, timber, and grass on the public domain. It would be impossible to estimate how many billion dollars from the public treasury would have been required to equal the incentive and subsidy to private enterprise which resulted from this expenditure of public resources. The important point is that this phase of American history illustrates a long-established policy of government-sponsored and publicly financed resource development.

Should such a policy be continued when it means the expenditure of public funds to bring undeveloped or partially developed resources into use? A rapidly growing population and the seemingly insatiable appetite of the American consumer indicate that additional production of all kinds of goods will be required. Will private enterprise provide the necessary expansion if left to its own devices? Webb argues that the existence and growth of capitalism in the United States and throughout the world is a product of the exploitation of the "great frontier" in America, Australia, and South Africa. It is contended that the future of the individual, of democracy, and of capitalism requires that the United States devote its energies to the problems of a frontierless society.[40]

[40] Walter Prescott Webb, "Ended: 400-Year Boom," *Harper's Magazine*, October, 1951, pp. 25–33, and "Windfalls of the Frontier," *Harper's Magazine*, November, 1951, pp. 71–77.

It is essential to the American economic system that vigorous and expanding private enterprise be maintained. The place of governmental action is likely to be even more important in the frontierless society of the future than in the frontier society of the past. This is a crucial type of responsibility that the public bears because the volume and direction of public expenditures can be major factors in the economy. Can these expenditures for resource development provide the climate for a healthy system of private enterprise with a minimum of government control? Preservation of the free enterprise system, conservative use of resources with future generations in mind, and immediate questions of national security are problems of public concern. Such public values associated with resource development are often more important than those affecting only the private user. It would seem to be an effective argument, in itself, to point out that developments paid for by the general public through their tax dollars are predominantly projects from which the general public will benefit. The President's Water Resources Policy Commission observed:

> Enough is known to support the judgment that the social values inherent in our water resources are immense and vital to the well-being of the Nation. These values may be either lost or realized, depending on whether we fail or succeed in achieving complete control and utilization of water resources. Thus, the problem has two aspects: the negative, involving losses from non-use, misuse, and low value use; the positive, represented by potential realization from better control and utilization. Public policy, therefore, should be aimed at minimizing losses and achieving the full potential of realization.[41]

Resource Development in a Dynamic Economy

Public investment in resource development has been likened to the casting of a stone into a pool of water with ripples spreading out toward the edge of the pool. Each ripple, as the motion moves away from the impact, is less in height than the preceding one until the effect fades out. In economic terminology, the "big splash" where the stone enters the water is the autonomous investment. The ripples on the surface of the pond are the induced investments spreading out at various levels in the economy. This concept of the

[41] President's Water Resources Policy Commission, Report of, *op. cit.*, Vol. I, p. 57.

broad effects of public investment is important in the formulation of policy regarding resource development because (1) the results of the public investment will be different if the economy is operating with full employment of resources than if there are unemployed resources available; (2) the amount of induced investment will vary with the type of resource development on which the public funds are expended; (3) the manner in which the public secures the funds it invests will affect individual incomes and private investment; and (4) the over-all effects of public investment will be related to trends in population as well as the demand for goods and services.

Public investment during a period of full employment of resources must utilize goods and services which would have been used elsewhere in the economy if there had been no such public expenditures. Conversely, public investment when there are idle resources available can result in the putting to productive use of such resources. In the first instance, public investment would appear to be undesirable except where activities are involved which can be carried on only by the government, where a type of investment vital to the public interest is not being made by private enterprise, or where customary public investments cannot be delayed. An example of the first exception is the atomic energy program which must be retained as a government endeavor for reasons of national security. The second exception may be illustrated by the failure of private enterprise to expand electric power generation rapidly enough to meet the needs of the light metals industry which plays a vital part in the national defense program. An example of the third exception is the necessity of building some new schools every year in the face of a rapidly increasing grade-school population.

A full employment economy carries with it the constant threat of inflation. For that reason, the public values which may appear to make public investment necessary during full employment should be weighed most carefully as part of the evaluation process. Similarly, at the other end of the scale, expenditures in times of unemployment should be given the same serious scrutiny to ascertain if the desired effect on income and employment will result. It should not be assumed that public investment is never justified in a full employment situation and always justified in a situation of underemployment of resources.

The extent of the inflationary effects of public investment is related to the manner in which the public secures the funds it uses. If autonomous public investment is financed through taxation or borrowing from consumers, the inflationary effects will be greatly reduced. The taxpayers will have to forego the purchase of goods and services equal in value to those used in the program of resource development. On the other hand, the inflationary effects may be large if the government borrows the money from banks rather than from consumers of goods and services. Obviously, public investment judged essential to the public welfare during a period of full employment should be financed by taxation or borrowing from private savers. Public investment in a period of unemployed resources might well be financed by borrowing from banks and savers who cannot find investment opportunities, and particularly so if a major objective of government action is to increase total income and purchasing power.

In periods of unemployment when the major aim of public investment is to increase employment and income, particular attention should be given to the type of development in which the public funds are to be invested. Public investment can take many forms: education, power facilities, mineral development, roads, inland waterways, research, public health, public buildings, irrigation, and resource conservation. They all vary in their capacity to provide direct employment, induce investment, and stimulate secondary employment, and in the kinds of goods and services they utilize.[42] The social goals in view in making public investments should determine which type or types of expenditure, from among those listed above, are given priority.

Finally, the classical concept that, in a full employment economy, public investment must be offset by an equivalent decrease in investment and the use of resources elsewhere in the economy does not hold under conditions of an expanding population. A continuing increase in the size of the labor force makes possible an expanded economy, that is, new and expanded enterprises that do not threaten the existence of enterprises elsewhere. Marts has observed, "The consistent application of the argument that each ex-

[42] The Keynesian concepts of the marginal propensity to consume and the multiplier are pertinent to induce investment and stimulated employment. See John Maynard Keynes, *The General Theory of Employment, Interest and Money* (New York: Harcourt, Brace & Co., Inc., 1935), pp. 113–31.

pansion of the national plant is offset by a corresponding contraction elsewhere in the economy would lead to the untenable position that there has been no economic advantage to the nation in expanding westward from the original colonial beachheads along the Atlantic coast." [43] This point is important because it rules out the argument that the government can promote new industries, new businesses, and new farms in one area only at the expense of established enterprises in other areas. If effective demand exists for production from the new autonomous and induced investment, it means only that a new enterprise in one area rules out the possibility of a similar new enterprise elsewhere but not of established enterprises.

Functions of Economic Evaluation

Benefits-costs analysis and consideration of public values in resource development indicate that evaluation of projects and programs has four functions, which are to answer the following questions:

1. Should any project or program be developed?
2. Should this project or program be developed in preference to some other project or program?
3. Should the approved project or program be developed at this time?
4. Should the approved project or program be developed in this particular way?

It should be a constant objective of those concerned with evaluation of resource development to improve the procedures of analysis in order that these questions may be answered. In the opinion of this writer, evaluation procedures must include a combination of economic analysis and value judgment. The individuals who contend that the evaluation of public resource development can be handled entirely within a precise economic formula are as open to criticism as those who would ignore economic analysis and depend on judgment alone. Bunce has stated the problem well in the following excerpt:

[43] M. E. Marts, *An Experiment in the Measurement of the Indirect Benefits of Irrigation—Payette, Idaho*, U.S. Department of the Interior, Bureau of Reclamation, Boise, Idaho, June, 1950, p. 24.

One reaction to the problems thus raised has been to throw out all theory and deal pragmatically with each maladjustment as it occurred; in many cases this has led to oversimplification and a neglect of relationships that are of basic importance in any scheme of social planning. Ends have not been clearly stated, and means have not been closely related to the basic cause of the maladjustments. Temporary emergency measures and long-time adjustments have been confused, and palliatives have appeared better than more radical measures designed to attack the root of the problem because they eased the pain more rapidly.

A second reaction has been that of the so-called "theorists" who have been so aware of the complexities of the problems involved that no action appeared safer than any action. Usually they have been pessimistic and anticipated chaos, or futility, or dictatorship as a result of man's blind attempts to solve problems too complex for his mind to grasp fully.

Both these attitudes seem too narrow. Social control of economic matters is increasing and will probably continue to increase in the future, but the controls used will vary all the way from making a flexible price system function more efficiently, to the use of coercion and the limitation of property rights. The economics of today, therefore, must deal with individual economics, social economics, and the basic causes of divergence between individual and social net returns if it is to be useful in the formulation of social policies. Similarly, social planning should make use of relationships revealed through theoretical analyses in order to develop the most reasonable policies.[44]

Only through a balanced approach can public development of water resources be carried on with the maximum benefits to the nation's system of private enterprise and due consideration of the important public values involved.

[44] Arthur C. Bunce, *Economics of Soil Conservation* (Ames, Iowa: Iowa State College Press, 1942), pp. 154–55.

CHAPTER 13

Economic Feasibility of Irrigation

The four chapters immediately preceding have been designed to place irrigation development in its proper perspective with regard to such broad concepts as the integrated use of irrigated lands, the multiple use of water resources, the public interest in water resources, and the over-all evaluation of water resource development. At this point, attention will again be directed more specifically to the problems of irrigation development.

Determinations of the economic feasibility of proposed irrigation projects have received increasing emphasis through the years because of the difficulties experienced by settlers in meeting their financial obligations. Economic feasibility is probably the most important determination to be made in the total consideration of proposed irrigation projects. By comparison, studies to ascertain engineering feasibility may be comparatively simple and routine.

The procedure to be described here is, basically, one of determining the *financial* feasibility of irrigation. That is, the goal of this type of analysis is to determine whether or not the direct beneficiaries of irrigation development, the farmers, can repay the construction costs within the specified time period. In the case of single-purpose development, a determination of financial feasibility was, in effect, a determination of the total economic feasibility of the project. Other water users and beneficiaries in addition to the irrigation farmers were not considered. The procedures for determining financial feasibility remain important, however, although the irrigation project is a part of a multiple-purpose development. Inasmuch as irrigation is a water use in which private beneficiaries repay their allotted share of the costs, it is necessary to determine the financial feasibility in much the same manner as for single-purpose irrigation projects. Once the procedure for determining financial feasibility has been traced through, the problem will again be placed in the broader framework of economic feasibility.

Crop Adaptability

The problems of agricultural and economic feasibility of irrigation are influenced, first of all, by crop adaptability and the types of farming which may be possible. Crop adaptability is dependent on three factors: soils, climate, and markets. Determination of crop adaptability shades gradually from an agronomist's problem, related to soils and climate, into the economist's problem related to markets and the economy of the area. The agricultural economist generally can take as his starting point the results of investigations by engineers, soil scientists, and crop specialists.

Once (1) the engineers have determined that it is possible to get water to and over the land, (2) the soil scientists have studied the probable reaction of the soils to the application of irrigation water, (3) the agronomists have suggested the crops likely to give the best results in the light of the types of soils, the growing season, and other climatic factors, then (4) the agricultural economist comes into the picture. He has the job of determining whether or not it will pay off in dollars and cents.

The point to be emphasized is that there is an important problem of determining crop adaptability in relation to both physical conditions and economic factors. The economic problem as related to crop adaptability is primarily one of markets, i.e., profitable sale of the farm's production. If feasibility determinations are to be worth while, they must be based on realistic consideration of the demand for and supply of the agricultural products involved. Here are the implications of an unrealistic approach to the problem:

> The land use projections for new irrigation are largely derived from patterns existing at present in established irrigation projects. *The resulting large increases in sugar beets and potatoes are hardly compatible with the constancy of price relationships assumed in the value projections, nor with the general market prospects in the long run.* At least for these two commodities, if these projections should materialize, production costs would have to be remarkably favorable as compared to those in old established areas in order to meet regional competition. An increase of 75% in sugar beet production would require a drastic change in U. S. sugar policy.[1]

[1] Joseph C. Podany, *Prospective Marketing Position of Farm Products Adaptable to Irrigation in North Dakota*, Agricultural Economics Report 1, North Dakota Agricultural Experiment Station and U.S. Department of the Interior, Bureau of Reclamation, cooperating, February, 1951, p. 8.

Sugar beets are an important crop in many irrigated areas. The questionable tendency to include substantial acreages of sugar beets in computations of economic feasibility of proposed irrigation areas is noted above. The competitive position of sugar beets is being improved somewhat, however, in the view of research workers who have been studying the progress of mechanization in field and harvest operations.[2] Reduction of the migratory labor problem will be a significant economic and social gain in irrigated areas which produce sugar beets.

The demand for farm products is closely related to population trends. Podany noted: "Three population factors that affect the market outlook for North Dakota farm products are: the total national increase in population, the population shift to the Pacific Coast States, and the population shifts within the State—between farm and city." [3] It should be noted, also, that population changes associated with other phases of multiple-purpose development will be a factor in the market outlook.

A major aspect in past determinations of crop adaptability has been the assumption that high-value cash crops were essential to the success of an irrigation project. In many irrigated areas, the possibilities were limited to sugar beets or potatoes. More recently, irrigated pasture has been recognized as being in a competitive position as an income producer. Improved techniques in establishing and managing pastures together with favorable market trends for livestock and livestock products have combined to place irrigated pastures in a prominent position in planning irrigation developments.

Three studies in New Mexico indicated the competitive position of irrigated pastures. The authors of one study stated: "Well grown and well managed pastures can be expected to produce 1,000 to 1,500 pounds or more of beef to the acre." [4] In another study it was

[2] George H. Lambrecht and Walter L. Ruden, *Sugar Beet Costs and Management in Irrigated Sections of Western Nebraska*, Nebraska Agricultural Experiment Station Bulletin 341, May, 1942; E. M. Mervine and R. D. Barmington, *Mechanical Thinning of Sugar Beets*, Colorado Agricultural Experiment Station Bulletin 476, March, 1943; Harry G. Sitler and R. T. Burdick, *The Economics of Sugar-Beet Mechanization*, Colorado Agricultural Experiment Station Bulletin 411–A, April, 1950; Roy M. Gilcreast, *Sugar Beet Production in the Red River Valley*, North Dakota Agricultural Experiment Station Bulletin 363, December, 1950.

[3] Podany, *op. cit.*, p. 29.

[4] Glen Staten, H. B. Pingrey, and Marvin Wilson, *Irrigated Pastures in New Mexico*, New Mexico Agricultural Experiment Station Bulletin 362, July, 1951, p. 28.

noted: "Grazing beef cattle, if there is no margin or spread, will return, at the prevailing price for beef steers, a value per acre of pasture comparable to that received from cotton production." [5] The author of the third study observed that irrigated pasture "warrants investigation by the farmer as a possible use of diverted cotton acreage." [6]

Sizes and Types of Farms

Crop adaptability as determined by physical and economic factors provides the basis for beginning a study of the sizes and types of farms which may be expected to take shape on a new irrigation project. The best guide to the sizes and types of farms that can be expected to develop is likely to be found on the most similar operating project with sufficient history behind it to have achieved some stability. If data from an existing project are to be applicable to a new development, the old project should be similar in soils and climatic factors. It is unlikely that any situation will be found where old and new projects are exactly alike; so some interpretation of the experience on the old project will be necessary to fit it to the proposed development.

A study of existing projects in the Pacific Northwest as the basis for planning farms on the Columbia Basin Irrigation Project was Problem No. 1 of the twenty-eight separate problems included in the Columbia Basin Joint Investigations. Problem No. 1 was posed as follows: "On other northwestern irrigation projects where basic conditions are similar to those which will be encountered on the earlier units of the Columbia Basin project, what types of farm economy (including crops and crop programs) have been successful? Most successful? Unsuccessful, if any?" [7] Eight irrigation projects were studied in seeking answers to these questions.

A Nebraska study sought to determine some of the systems of farming suitable to the Tri-County area which is in the process of conversion from dryland farming to irrigation farming. Pertinent

[5] H. B. Pingrey, *Farm Income Possibilities in the Pecos Valley, New Mexico,* New Mexico Agricultural Experiment Station Press Bulletin 1042, September, 1950.

[6] William P. Stephens, *Farm Incomes in the Mesilla Valley, New Mexico,* New Mexico Agricultural Experiment Station Press Bulletin 1043, October, 1950.

[7] U.S. Department of Agriculture, Bureau of Reclamation, *Columbia Basin Joint Investigations: Farm Experience Studies* (Washington, D.C.: Government Printing Office, 1942), p. ix of the Foreword.

questions were raised regarding the size of farms related to acres irrigated, as follows:

> Apparently an appreciable number of farms in the Tri-County area are becoming smaller. The adjustment in size does not appear to be completed. Logically, several questions arise: How small will the farms become? How much land is required to keep the average farm family labor force occupied when the land is all irrigated, half irrigated, one-fourth irrigated? How much labor is required on irrigated land compared with dry land? What size of farm under irrigation fits the average managerial capacity of farm operators?
>
> In relating the acres of land to the available labor force, the effect of modern farm machinery and power upon the working capacity of labor must be considered. One man can perform the field work on more acres now than was possible even as recently as 5 or 10 years ago.[8]

Sizes and types of irrigated farms are related closely to the amount and kind of diversification which may be feasible. Three major kinds of diversification can be noted: (1) horizontal diversification, (2) area diversification, and (3) vertical diversification. The first kind refers, of course, to the concept of diversifying farm production by the organizing of additional enterprises alongside of those already in existence; i.e., an intensification of production on a given area of land. Area diversification refers to the integration of irrigated lands with dryland resources and has been discussed in Chapter 9. Vertical diversification has been described by Doane as an organizational structure wherein the primary producer handles farm products for one or more steps beyond raw production. It may involve such additional activities as transportation, processing, storing, or retailing by individual farmers or by farmer cooperatives. Vertical diversification may carry all the way from farm production to the final consumer. Its exact character will depend on the particular type of agriculture involved.[9]

The extent to which diversification of any kind can be incorporated into the development of new irrigated areas will affect the sizes and types of farms, the amount and kind of agricultural pro-

[8] T. S. Thorfinnson and A. W. Epp, *Systems of Farming for the Tri-County Irrigation Area in Nebraska*, Nebraska Agricultural Experiment Station Bulletin 393, January, 1949, p. 17.

[9] D. Howard Doane, *Vertical Farm Diversification* (Norman, Okla.: University of Oklahoma Press, 1950), p. 3.

duction, and the gross and net farm income. These are the determining factors in the financial feasibility of irrigation.

The Budget Analysis

How are physical and economic data converted to a measure of financial feasibility? In other words, how is a dollar-and-cents figure computed which shows whether or not the irrigated farms can repay the construction costs within the specified time period? The procedure used is known as the *budget method.* It has been defined, "to pre-estimate the probable receipts and expenditures and net income of promising alternative enterprises or combination of enterprises." [10] The budget method involves, first of all, the outlining of crop and livestock enterprises. Average yields are then applied to the acreages of crops to estimate production from each crop. The livestock enterprises will utilize all or part of the crop production. The budgeting process usually involves some trial-and-error adjustments in order to secure the most desirable balance between the crop and livestock enterprises. From the final pattern of production, it is possible to estimate the amounts available for sale after allowing for crops used for feed and seed, and for the livestock and livestock products consumed in the home. Application of normal prices to the production and totaling, together with any gain in inventory, gives a gross farm income figure. Obviously, the same difficulties regarding price levels will arise here as in the evaluation procedure discussed in Chapter 12. It is also essential that yield figures be selected with care in order to avoid a questionable estimate of production. Production figures not only enter into estimates of income but, eventually, of financial feasibility.

The other side of the budgeting process is concerned with estimates of all expenditures (costs) involved in the operation of the irrigated farm. Cost items include expenditures for feed, seed, fuel, livestock expenses, repairs, depreciation, insurance, real estate and personal property taxes, operation and maintenance of the irrigation system, fertilizer, hired labor, and inventory decrease. When these items are totaled and subtracted from the gross farm income,

[10] John D. Black, Marion Clawson, Charles R. Sayre, and Walter W. Wilcox, *Farm Management* (New York: The Macmillan Co., 1947), p. 368.

a net farm income figure is secured. It represents the return to the farmer for his labor and management and the use of the total capital invested in the farm business, in addition to the use of a house and all farm products consumed, after paying all business expenses.

A return to the farmer for his labor and management and an interest charge on the capital investment must be deducted to arrive at a figure which reflects the ability of the irrigated farm to repay construction costs. The capital charge is commonly computed by using the "going rate of interest." The labor and management figure is not so easily determined and requires further consideration.

The farmer's return to labor and management is most commonly a residual figure after the deduction from net farm income of an interest charge on the capital investment. Sometimes, however, the earnings on the capital investment are computed as a residual after the deduction of an estimate of the value of the farmer's labor and management. In such instances, the farmer's labor and management should be valued on the basis of the amount the farmer could earn in alternative opportunities. In determining financial feasibility, the ability of the farm to repay construction costs is a residual after the deduction of both an interest charge and a labor-management figure from net farm income.

In many feasibility determinations, an item termed *family living allowance* is used instead of the farmer's labor and management return. The two are not synonymous, however, and differences result from their use. The farmer's labor and management return may be more or less than the family living allowance judged consistent with social goals. The level of living judged adequate for the farm families on a new irrigation project may be an important factor in whether or not the project is determined to be financially feasible. In effect, a project can be determined to be feasible at the expense of the level of living of the farm family. There would be a tendency to reduce the family living allowance in the case of a marginal project so that the residual could be increased and the feasibility determination improved. As a concept based on social goals, it appears that the family living allowance is more likely to be subject to such maneuvering than is the farmer's labor and management return based on opportunity cost.

The Value of Water

The residual arrived at through the budgeting procedure described above is not the same as the value of water, i.e., the net gain in product value through the application of water. It has been stated:

> The value of water is always larger—usually much larger—than ability to pay, because it must cover the estimated operation and maintenance costs of the proposed project in addition to the annual construction payments. Moreover, any computation of ability to pay must allow a reasonable margin between the net value of water and the amount to be charged water users as an inducement for them to participate in the project and as a "safety factor." [11]

In the case of desert land, the entire agricultural production can ordinarily be credited to irrigation. This is not the case when land which is being farmed without irrigation is brought under the ditch. Only the difference between what the land produced without irrigation and what it produces with irrigation can be considered to represent the return from irrigation. Good returns on wheat farms as a result of favorable climatic conditions and high prices have temporarily narrowed that difference and created a lack of interest in irrigation in dryland farming areas. Schaffner wrote:

> In order to properly evaluate the economic feasibility of irrigation, information is needed for anticipating the effects of irrigation on farm income in the proposed irrigation areas. It is essential to have a good knowledge of the present income position of dryland farmers and their farm investment and organization in order to appraise realistically the changes in farming, capital requirements and tenure arrangements which will come about with irrigation development.[12]

A study of irrigation farming in the Province of Alberta, Canada, revealed that, in the more stable farming area, irrigation had no advantage over dry farming; but in the more hazardous farming

[11] Stanley W. Voelker and Elmer C. Hunter, *Value of Water for Irrigation in the Roaring Fork Basin of Colorado*, U.S. Department of Agricultural Economics, Bureau of Agricultural Economics, in cooperation with Colorado Agricultural Experiment Station, May, 1950, p. 6.

[12] L. W. Schaffner, *Present Farm Economy in Three Proposed Irrigation Areas of North Dakota*, Agricultural Economics Report 3, North Dakota Agricultural Experiment Station and U.S. Department of the Interior, Bureau of Reclamation, cooperating, May, 1951, p. 3.

area, definite gains were associated with irrigation.[13] Such analyses of the *with* and *without* situations in every project area are essential to determination of the value of water.

The residual computed in the budget analysis plus the operation and maintenance cost and increased interest and tax charges resulting from irrigation, which were deducted as a part of farm operating costs, will give a total which is an approximation of the value of water. The budget method can be checked by an analysis of the landlord's share of net crop returns per acre under irrigation as compared with his share without irrigation. This method has been described as "the so-called 'income-to-land' method, which is essentially a computation of the probable amount of the landlord's share of the increase in average annual crop returns by virtue of the proposed irrigation project." [14] Gross value of water to land is defined as "the increased production from the land which is expected from the application of project water, evaluated at some assumed price level," while the net value of water to land is the gross value less certain increased land costs which accompany the project, including (1) interest on any increased investment, (2) interest on the cost of new land development, and (3) increased general property taxation.[15]

Both the budget analysis and the determination of net value of water to land are concerned with financial feasibility of irrigation, i.e., ability to repay construction costs and to pay additional costs incurred by the farm operator and landlord as a result of irrigation. The President's Water Resources Policy Commission wrote the following on the subject of financial feasibility:

> Financial feasibility has been urged by some as the determining factor in evaluation, that is, they believe that all water resources projects should be self-liquidating. This view implies that Federal agencies should seek out sound business opportunities wherever they may be found in the water resources field.
>
> The basic fallacy in such reasoning is that it seeks to transfer to public investments the limitations common to private investments. The Federal Government seeks to conserve and develop the Nation's natural resources for the general welfare and not for profit. Hence

[13] C. C. Spence, B. H. Kristjanson, and J. L. Anderson, *Farming in The Irrigation Districts of Alberta*, Dominion of Canada, Department of Agriculture Publication 793, Technical Bulletin 61, November, 1947, p. 63.

[14] Voelker and Hunter, *op. cit.*, p. 5.

[15] *Ibid.*, p. 5.

> financial feasibility is not the same as economic feasibility. Financial costs and returns should be considered in analysis, but financial feasibility alone should not determine the desirability of a program or project. For this reason the Commission is recommending that Congress eliminate the requirement that irrigation projects show financial feasibility.[16]

Some of the benefits of irrigation development which accrue to local nonfarm beneficiaries, when included in the consideration of an irrigation project, shift the viewpoint from strict financial feasibility to one of economic feasibility. Inclusion of local nonfarm benefits takes irrigation feasibility in the direction of the broad type of resource evaluation discussed in Chapter 12, although these benefits arise entirely from irrigation. However, if the local nonfarm beneficiaries should happen to be included in a conservancy district, the problem reverts to one of financial feasibility.

Local Nonfarm Benefits

The benefits which accrue to other than the irrigation farmers at the project level have been referred to as *local nonfarm benefits.* They are reflected in the towns and villages which are the community and trading centers of the area. Numerous attempts have been made to establish a ratio which might be applied to determine the local nonfarm benefits of irrigation development: i.e., two nonfarm persons will be able to earn a living for every person placed on an irrigated farm. Some such figure might represent an average of irrigation projects but would mean little with respect to a particular irrigation project. The character of the irrigation project from which the benefits flow is most important and the nature and extent of the benefits will vary from project to project. This point was illustrated in striking fashion by Goldschmidt in a study of two California communities. The two irrigated areas have comparable natural resources on which to build, but one of them has developed as an area of small farms while the other has a pattern of large farms operated under a corporate system of management. The local nonfarm benefits of the two areas present a marked contrast. The findings of Goldschmidt's study can be summarized under four main headings:

[16] President's Water Resources Policy Commission, Report of, Vol. I: *A Water Policy for the American People* (Washington, D.C.: Government Printing Office, 1950), p. 59.

1. Retail trade: There were sixty-two business establishments in the small-farm community compared to thirty-five in the large-farm community. The volume of retail trade was $4,383,000 in the small-farm community as against $2,535,000 in the large-farm community during the twelve months analyzed. Expenditures for household supplies and building equipment were more than three times as much in the small-farm community as in the large-farm community.

2. Level of living: The small-farm community supported about 20 per cent more people per dollar volume of agricultural production and at a higher level of living. Over one-half of the earning population in the small-farm community were independent businessmen, professional people, and farmers, while less than one-third were agricultural wage laborers. In the large-farm community, almost two-thirds of the gainfully employed were agricultural wage laborers.

3. Public services: The small-farm community had four elementary schools, one high school, and three parks compared with one elementary school and one playground in the large-farm community. Paved streets, sidewalks, garbage disposal, and sewage disposal were similarly favorable to the small-farm community.

4. Quasi-public services: The small-farm community had more than twice as many civic and recreational organizations, twice as many churches, and two newspapers as compared to one in the community of large farms.[17]

It is not difficult to deduce from the above summary that the local nonfarm benefits, both those in monetary terms and in nonmonetary terms, were far greater in the community of small farms. The comparison illustrates the necessity for evaluating each project on its own merits. One of the most comprehensive studies yet made of local indirect (nonfarm) benefits involved the Payette Irrigation Project in Idaho. Using an income approach to the measurement of local benefits, Marts developed an *indirect benefit factor.* For each $1 of net income realized at the primary level of irrigation agriculture, the nonfarm segment of the local economy realized $1.27 in net income. The concept of the local multiplier is presented to indicate how much the income from a primary industry is mul-

[17] *Small Business and the Community,* U.S. Senate Small Business Committee Report 13, December 23, 1946, pp. 5–6.

tiplied within the local economy. The multiplier is expressed by the ratio between the total local benefits and the direct benefits—2.27 to 1.00.[18]

Reduction in the cost of supplying public services may also be a monetarily measurable benefit to the entire local economy. A 1938 study showed that irrigation resulted in a more stable tax base for the support of community government and that population density associated with irrigation resulted in lower public school costs—$79.07 per student in irrigated districts and $119.27 per student in dryland districts.[19]

Benefits Beyond the Project Area

Selby divided indirect benefits into two classes: (1) benefits accruing to the nation as a whole which are distributed very widely and relatively evenly to a large proportion of the population; and (2) benefits accruing to certain individuals, such as the handlers of the commodities produced, the owners of property near the project, and the suppliers of goods and services to farmers on the project. These two classes are called *national* benefits and *local* benefits.[20] The local benefits have been considered above but what is the nature of the national benefits of irrigation?

In discussing irrigation development in the Scottsbluff area of Nebraska, Terral points out that the nation has shared in the prosperity of the area. Shipped to the town were 283 carloads of freight from seven states in 1900 and 7,144 carloads from thirty-nine states in 1942—an indication of economic growth based on irrigation.[21] In addition to the increased volume of trade, greater stability of incomes in irrigated areas is highly significant. For example, it has been noted that 63 per cent of agricultural production in Montana came from irrigated lands in 1936, a drought year,

[18] M. E. Marts, *An Experiment in the Measurement of the Indirect Benefits of Irrigation,* U.S. Department of the Interior, Bureau of Reclamation, Boise, Idaho, June, 1950, p. 38.

[19] P. L. Slagsvold and J. D. Mathews, *Some Economic and Social Aspects of Irrigation in Montana,* Montana Agricultural Experiment Station Bulletin 354, January, 1938, p. 13.

[20] H. E. Selby, "Indirect Benefits from Irrigation Development," *Journal of Land and Public Utility Economics,* XX, No. 1 (February, 1944), 45–51.

[21] Rufus Terral, *The Missouri Valley* (New Haven, Conn.: Yale University Press, 1947), p. 100.

although only 36 per cent of the harvested acres were irrigated that year.[22]

A particular irrigation project or type of irrigation development may create negative benefits as well as positive benefits. If, for example, the agricultural economy requires a large number of seasonal laborers who become relief cases during part of the year, a social cost is created which should be subtracted from the total local benefits of the project. Similarly, if an irrigation project is developed which creates a type of farming making it necessary for the federal government to subsidize the bringing in of laborers from other areas of the nation or the importation of foreign nationals, a social cost is created which offsets some of the benefits at the local level. It should be noted, of course, that this social cost may be determined to be in the public interest because of the nature of the agricultural production involved.

Benefits of irrigation development which accrue at the national level are largely extramarket values. Such benefits are associated with the broad gains stemming from an expanded resource base and increased production. The President's Water Resources Policy Commission has stated:

> A commercial property has *dollar* value according to scarcity; a *Nation's* resources have *security* value if they are so plentiful as to be cheap. Thus a successful irrigation or drainage program might lead to a great reduction in the dollar value of some particular crop; the more that is planted and protected, the less it is worth; and *the stronger is the Nation.* This basic conflict between private values based on scarcity and public values based on plenty lies at the very heart of the conservation problem. It is to increase national wealth that government invests public capital in the improvement of the resource base.[23]

[22] R. B. Tootell, "An Appraisal of Montana Agriculture at Mid-Century," *Montana Agriculture at Mid-Century,* Montana Agricultural Experiment Station, 1951.

[23] President's Water Resources Policy Commission, Report of, *op. cit.,* Vol. I, pp. 60–61.

CHAPTER 14

Irrigation in Humid Areas

Most persons picture irrigated agriculture as being limited to the arid and semiarid regions of the western United States. Promotion and publicity are associated with the large-scale projects, which are better known than smaller developments. Very little is heard about the importance of small irrigation projects, not only to the economy of the West but to many other areas as well. The seventeenth U.S. Census (1950), *Irrigation of Agricultural Lands*, indicates the significance of small irrigation. Single-farm irrigation enterprises comprised 90 per cent of the irrigation developments and 49 per cent of all the irrigated acres in the seventeen western states. These small irrigation enterprises contained 39 per cent of all the irrigated farms in the seventeen western states.

All the thirty-one humid states reported irrigation in the 1950 Census. Florida reported 6,075 farms irrigated. Leaders in the East were Massachusetts with 1,053 irrigated farms, New Jersey with 1,033 irrigated farms, and New York with 888 irrigated farms. In the Midwest, Michigan had 995 irrigated farms, Ohio had 458 and Wisconsin 354.

Why does irrigation have such wide appeal in so many different types of farming areas? Are areas of humid climate deficient in rainfall for satisfactory agricultural production?

Climatic Characteristics of Humid Areas

Agricultural areas having twenty inches or more of annual precipitation are generally considered to have adequate moisture for crop production without irrigation. Klages has classified regions of different annual precipitation as follows:[1]

[1] By permission from *Ecological Crop Geography*, by K. H. W. Klages, p. 158. Copyright, 1942, The Macmillan Co., New York.

TABLE 8

Regions Classified as to Annual Precipitation

Annual Precipitation in Inches	Class	Per Cent of World Area
Less than 10	Arid	25.0
10–20	Semiarid	30.0
20–40	Subhumid	20.0
40–60	Humid	11.0
Over 60	Wet	14.0

The characteristic of humid-area agriculture which gives rise to irrigation is the prevalence of brief but severe drought periods during the growing season. The occurrence and effect of such drought periods seems to be about the same whether the annual rainfall is 25 or 55 inches. For purposes of this discussion, areas having more than 20 inches of rainfall will be referred to as humid with no attempt being made to consider subhumid, humid, and wet areas separately.

The occurrence of drought periods in central Georgia is shown in Table 9. This compilation indicates that damaging dry periods occur sometime during the growing season every year. A similar situation with respect to the occurrence of drought periods is revealed regarding states in the Midwest.

> Rainless periods of duration of 1 or more weeks during the crop-growing season frequently occur in humid climate states. In Michigan, during a 10-year period there were on the average 7 periods each year from 1 to 2 weeks in duration in which there was no rainfall. In Iowa, there were 8 such periods; and in Ohio, 5. A rainless period of 2 to 3 weeks' duration occurred on the average twice each year in Minnesota and once in each of the other states. Rainless periods of 3 weeks or more are comparatively rare.[2]

Irrigation as carried on in humid areas is commonly referred to as *supplemental irrigation*. The term means that the irrigation water is supplementary to the natural rainfall rather than being the primary source of moisture as in the arid and semiarid West. Supplementary irrigation is used generally to prevent retardation of growth

[2] Reprinted with permission from Orson W. Israelsen, *Irrigation Principles and Practices* (2d ed.; p. 348). Copyright, 1950, John Wiley & Sons, Inc., New York.

TABLE 9

FREQUENCY OF GROWING SEASON DROUGHT PERIODS 14 DAYS OR MORE IN DURATION, MIDDLE GEORGIA, 1929–47

Year	Length of Drought Periods—Days									Total Days Drought Each Growing Season
	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	
1929		16					17	19		52
1930	14		14	17		21	30 18	18		132
1931		15	18	21			15	20	15	123
1932			20	15						35
1933			14		16		21			51
1934		15					15	20	15	65
1935			19			16	18	20		73
1936		20	31	16		16	14			97
1937	14						19			49
1938			18			18	23	20		79
1939	20			24			18	31		109
1940			26				23	21		94
1941		14	20				25	17	14	90
1942		25		18			19	19		95
1943				14	16		18	31		79
1944		15	31				15		15	76
1945	15			15				15		45
1946					17	14				31
1947		15	17	27						59

Source: Everett H. Davis, "The Development of Irrigation in Georgia," *Better Crops with Plant Food*, June-July, 1948. From records of Weather Bureau as recorded at Griffin, Ga.

during periods of drought.[3] The authors of an Oklahoma study observed:

> Irrigation in most of Oklahoma is a matter of having water available at critical stages in plant growth. There are times when a few days of dry weather can mean the difference between a good crop and a poor one, but we seldom need to depend on irrigation for *all* the moisture needed by a crop.[4]

[3] F. E. Staebner, *Supplemental Irrigation*, U.S. Department of Agriculture Farmers' Bulletin 1846, October, 1940, p. 1.

[4] *Irrigation for Oklahoma*, Oklahoma Agricultural Experiment Station Circular C–131, December, 1948, p. 5.

Regarding irrigation in Missouri, Rubey wrote:

> Most crops in Missouri suffer in most years from insufficient rainfall at critical times during their growth. Much of the rainfall is not effective, since less than one-quarter of an inch will not penetrate the ground sufficiently and since a considerable percentage of the heavier rainfall, of three-quarters of an inch or more, may be lost in runoff, which does not soak into the ground. . . .[5]

Much the same point of view on the need for supplemental irrigation was expressed in a South Carolina study in these words:

> The distribution of rainfall in South Carolina has caused a number of farmers to turn to irrigation. Even with an annual rainfall of 45 to 55 inches for the state, crops often suffer for moisture during the growing season. Not only is it a matter of unevenly distributed rainfall, but soil conditions are also influential on the need for supplemental irrigation.[6]

It appears that professional students of the problem give support to supplemental irrigation as a tool to offset drought periods in humid states. What has been the reaction of farm operators to humid-area irrigation?

Trends in Humid-Area Irrigation

The last decade has witnessed a substantial increase in irrigation in humid areas. Consideration of the place of irrigation in the agriculture of humid farming areas, however, is not new. The first irrigation investigations conducted by the U.S. Department of Agriculture more than sixty years ago dealt with irrigation in the humid eastern part of the country.[7] This emphasis reached a peak at the turn of the century. Results of these early investigations are particularly interesting because many of the results are similar to the results being reported in current literature. The New Jersey Agricultural Experiment Station noted that in 1897 and 1898, years of abundant rainfall in April and May, the yield of hay averaged 2.65 tons per acre; the yield of crimson-clover forage averaged 8.5 tons

[5] Harry Rubey, *Supplemental Irrigation for Missouri and Regions of Similar Rainfall*, University of Missouri Engineering Experiment Station Bulletin 33 (rev. 1947), p. 7.

[6] Henry Z. Duffie, Jr., *Supplemental Irrigation in South Carolina*, Clemson Agricultural College Extension Service Circular 327, February, 1949, p. 3.

[7] U.S. Department of Agriculture, *Report of the Secretary of Agriculture, 1893*, p. 434.

per acre; and oats and pea forage averaged 6 tons per acre. The year 1899 saw a deficiency of rainfall in April and May with the result that hay yielded but a fraction over one ton per acre, crimson-clover forage but 5 tons, and oat and pea forage only 3.3 tons per acre. This situation had a serious effect on the dairy industry. Need for investigation of the feasibility of irrigating forage crops was evident but all experimental work at that time was on fruit and vegetables.[8]

The Wisconsin Agricultural Experiment Station reported on the results of irrigating other than fruit and vegetable crops. The average increase in the yield of clover hay on irrigated land over that from unirrigated land had been 2.5 tons per acre; the average increase in yield of corn had been 26.95 bushels per acre; and potatoes showed a gain of 83.9 bushels per acre. The author commented, "During eight years of critical study, from 1894 to 1901, on the influence of moisture on crop production, there has not been a single year when irrigation has not very materially increased the yield of one or more crops grown upon a soil reasonably retentive of moisture." [9]

Research studies of the relationship of irrigation to the character of the soils in New Jersey and Wisconsin were reported the next year. The author of a New Jersey report concluded that irrigation would be of service every year for one or more crops and that irrigation on a small scale was entirely practicable and profitable. A serious problem was encountered, however, of getting water through open ditches in areas of light soils where seepage losses were high. It was observed that this problem was most difficult "in the districts where irrigation would be found to be most serviceable." [10]

In Wisconsin, irrigation studies were made on a heavy clay soil at Madison and on a very sandy soil at Stevens Point. Whitson observed:

> The unusually large precipitation of the season made it impossible to add water by irrigation on the land at Madison without the cer-

[8] Edward B. Voorhees, *Irrigation in New Jersey,* Office of Experiment Stations Bulletin 87, Washington, D.C., 1900, p. 10.

[9] F. H. King, "Irrigation Experiments in Wisconsin," *Irrigation Investigations for 1901,* under the direction of Elwood Mead, Office of Experiment Stations Bulletin 119, Washington, D.C., 1902, pp. 313–52.

[10] E. B. Voorhees, "Irrigation Investigations in New Jersey," *Irrigation Investigations for 1902,* under the direction of Elwood Mead, Office of Experiment Stations Bulletin 133, Washington, D.C., 1903, pp. 235–48.

> tainty of injuring all crops except hay, but at the same time allowed us to study the effects of previous irrigation on the soil. The rainfall was less during the latter part of the season at Stevens Point than at Madison and the lighter character of the soil allowed it to dry more rapidly, so that irrigation was helpful to a limited extent.[11]

A few years later, Bowie observed that, in the North Atlantic States, the advantages to be gained from irrigation are limited to fruit and vegetable crops.[12] This statement is something of a contradiction of the several reports just cited. It is true, however, that most irrigation in humid areas continued to be limited primarily to specialty crops until the post-World War II period. Some interest in irrigation of other crops was evidenced during the 1930's. Beasley notes that, in Missouri, a number of farmers became interested in the irrigation of field crops during the drought seasons of 1934 and 1936.[13]

The rapid expansion of irrigated agriculture in humid areas is illustrated by the situation in two states. In 1946, there were about 250 portable-pipe sprinkler systems in Michigan used on about 10,000 acres. Three years later there were nearly 1,000 systems serving well over 40,000 acres.[14] The 1939 Census showed a total of 5,948 acres irrigated in New York. By 1946, according to studies made in the potato-producing area of Suffolk County, Long Island, the area irrigated in that county alone was more than 10,000 acres.[15]

The significance of irrigation in the changing agriculture of the southern states is discussed with reference to South Carolina as follows:

> The widespread interest in irrigation is a natural outcome of the change in the type of agriculture that has been taking place in South Carolina since the coming of the boll weevil. Cotton acreage has been greatly reduced, and the acreage of truck, fruit, and specialized crops has greatly increased. The production of feed and grazing crops for livestock is also increasing. Thinking farm people, therefore, turned

[11] A. R. Whitson, "Irrigation in Wisconson in 1902," *Irrigation Investigations for 1902*, under the direction of Elwood Mead, Office of Experiment Stations Bulletin 133, Washington, D.C., 1903, pp. 223–34.

[12] Aug. J. Bowie, Jr., *Irrigation in the North Atlantic States*, Office of Experiment Stations Bulletin 167, Washington, D.C., 1906, p. 7.

[13] R. P. Beasley, *Supplemental Irrigation in Missouri*, Missouri Agricultural Experiment Station Bulletin 410, August, 1939, p. 5.

[14] F. W. Peikert, "More Water Means More Corn," *Successful Farming*, XLVII, No. 8 (August, 1949), 112–15.

[15] R. N. Hampton, "Irrigation of Potatoes on Long Island," *Farm Economics* (Cornell University, Ithaca, N.Y.), 157 (October, 1947), pp. 4076–78.

> to the utilization of resources that were not given much consideration under the old farming system. The better use of water is certainly a valuable resource under many circumstances with those types of agriculture adopted by farmers during the past three decades. The increasing interest in this subject will develop further as ways and means are found to make irrigation more effective on farms.[16]

It is interesting to note that Williams recognized the potentialities of irrigation in the southern states as long ago as 1911 when he said that irrigation could help to convert worn-out cotton and corn land.[17] It may be in order at this point to inquire into the reasons for the rapid expansion in humid-area irrigation since World War II, and at the same time, to determine why such development was delayed so long in view of the optimistic reports published more than forty years ago. Three reasons have been listed for the increase in interest regarding supplemental irrigation and they are as follows:[18]

1. The detrimental effects of short drought periods during the growing season.
2. The availability of improved portable irrigation equipment.
3. The desire of farmers to eliminate weather risks in the production of high-income farm products.

The relation of irrigation to drought periods has been discussed in the above paragraphs. The second point will be discussed in connection with technology in humid-area irrigation and the third in the section concerned with supplemental irrigation as an insurance measure.

Technology in Humid-Area Irrigation

The success of small-scale irrigation projects has been facilitated by significant improvements in the mechanical devices used, i.e., pumps, motors, pipes, and sprinklers. Efficient pumps make it possible to lift more water a greater distance at less cost. As a result, many more small pumping projects become economically feasible. This fact is especially important in humid areas where the water

[16] Duffie, *op. cit.*, in the Foreword to the circular.

[17] Milo B. Williams, "Possibilities and Need of Supplemental Irrigation in the Humid Region," *Yearbook of the Department of Agriculture, 1911*, pp. 309–20.

[18] John R. Carreker and W. J. Liddell, "Rights of Irrigation Research in Georgia," *Agricultural Engineering*, XXIX, No. 6 (June, 1948), 243–44.

source (streams, ponds, sumps, and wells) is almost invariably below the level of the land to be irrigated.

The spread of rural electrification and the development of more efficient small tractors and stationary engines provide better sources of power. It is possible to get a power unit that more nearly fits the requirement of the pump than when the older, more cumbersome field tractors were used. Electric motors in particular can be fitted more exactly to the power requirements of the pump. Many electric motors and pumps are built as a unit. Availability of electricity means greater convenience and less man-hours required. Pumping plants can be so installed that a flip of the switch is all that is necessary to start the flow of water to the crops. Use of electric motors or other small power units also eliminates the competition for use of the tractor between field operations and pumping for irrigation.

Irrigation water can be applied by the open ditch method or with sprinkler systems of various types. The development of light-weight pipe was an important advance in sprinkler irrigation. The light-weight pipe is easily moved and can be handled with a minimum of labor. Sprinkler irrigation may be a solution for the shortage of farm labor trained in gravity irrigation. Successful operation of a sprinkler system does not require irrigators with years of experience.

The use of a sprinkler system makes it possible to irrigate areas where development was previously impossible. Many soils are too shallow to be leveled for gravity irrigation without exposing the gravel subsoil. Sprinkler irrigation makes it possible to irrigate rolling land without expensive leveling. Higher yields are reported with less water when applied by sprinklers as compared with the open ditch method of irrigation. In some areas, water saved by sprinkler irrigation may make possible the development of other new lands.

The following listing of the advantages of sprinkler irrigation over gravity irrigation is a composite of the advantages set forth in several discussions of the subject:[19]

1. More efficient use of water saves one-half to two-thirds of the water otherwise necessary.

[19] M. R. Lewis, "Sprinkler or Other Methods of Irrigation," *Agricultural Engineering*, XXX, No. 2 (February, 1949), 86–87; K. W. Sawyer, "Sprinkler Irrigation in the Willamette Valley," *Reclamation Era*, XXXIII, No. 9 (September, 1947); F. J. Veihmeyer, "Sprinkling for Irrigation," *American Fruit Grower*, June, 1949; Everett H. Davis, "The Development of Irrigation in Georgia," *Better Crops With Plant Food*, June-July, 1948.

2. Complete control of water at all times, eliminating leaching and erosion.
3. Uniform application of water over an entire field regardless of topography. Rate of application can be varied to needs of different soils.
4. Additional land may be irrigated as a result of more efficient use of limited water supplies.
5. No supply ditches to be constructed and maintained.
6. Land, which would be occupied by ditches in gravity irrigation, is available for farming.
7. No ridges, rills, or ditches to increase cost of farming.
8. No expensive leveling or grading to prepare land for irrigation.
9. Inexperienced labor can handle water satisfactorily.
10. May require less labor than gravity irrigation and fit farm labor schedule better.

It is often easy to exaggerate the effect of a particular technological development in agriculture but it is doubtful if the importance of the modern portable irrigation systems can be given too much emphasis. American farmers have usually been quick to adopt new mechanical contrivances. They have been slower, in many instances, to adopt new farming practices not so directly associated with mechanization. The fact that the modern portable irrigation systems put humid-area irrigation in the category of mechanization may be important in the rapid increase in supplemental irrigation. Certainly, the application of irrigation water by means of a portable system involves less change than if a farm is converted to the gravity-flow type of irrigation.

It may be significant, too, that the perfection of efficient portable irrigation systems occurred during a period of high farm income. Cost-returns relationships have been such that irrigation systems could be paid for rather easily from the increased production. In addition, high farm returns made possible sufficient capital accumulation so that cash could be paid for many irrigation systems. A farm operator is more likely to make such an investment if he has the money on hand and borrowing is unnecessary.

Supplemental Irrigation as Insurance

It is more difficult to establish irrigation on a permanent basis in the humid areas where the need for irrigation varies from year

to year. Irrigation may be only one of several means that the farm operator can use to combat those dry seasons which have an adverse effect on crop production. Four countermeasures to drought have been suggested:[20]

1. Increase storage capacity of the soil for moisture.
2. Reduce water needs of the crop by (*a*) using plants requiring less water and (*b*) farming practices increasing efficiency of water use.
3. Adjust crop calendar so that the harvest will come before drought is severe.
4. Make up water deficiency by supplementary irrigation.

The use of one or more of the first three measures listed may not eliminate the fourth course of action as something to be given serious consideration. Some farm operators place supplemental irrigation in the category of insurance against a hazard that is uncertain as to frequency and time of occurrence. Davis quoted Georgia farmers as saying, "It is the best crop insurance I ever had even though I might not need irrigation every season." It was pointed out that vegetable growers in south Georgia lost as much as $300 per acre in 1946 because of setbacks caused by lack of moisture.[21] A Missouri report observed, "Irrigation in Missouri should be viewed partly as insurance against droughts and partly as a method of increasing the yield and value of crops." [22] Powers reported, "The study of supplemental irrigation on subhumid lands over a 30-year period leads to the conviction that light irrigation would be valuable drought insurance throughout much of the so-called humid and subhumid areas of the country." [23]

There are two major problems associated with the concept of irrigation as insurance. The first is concerned with the maintenance of an irrigation system in usable order during years when irrigation is not required. The drought period which occurs following several wet years may reveal that the irrigation system has been allowed to fall into a state of disrepair and is not available for use when needed.

[20] C. W. Thornthwaite, "Climate and Moisture Conservation," *Annals of the Association of American Geographers*, XXXVII, No. 2 (June, 1947), 87–100.

[21] E. H. Davis, *Irrigate for More Profits*, Georgia Agricultural Extension Service Bulletin 542 (rev. June, 1948), p. 3.

[22] Rubey, *op. cit.*, p. 57.

[23] W. L. Powers, "Thirty Years of Supplemental Irrigation Studies," *Agricultural Engineering*, XXI, No. 8 (August, 1940), 311–12.

Obviously, the insurance concept requires considerable long-range management on the part of the farm operator. The second major problem is concerned with the large investment in an irrigation system which might produce satisfactory returns every year. Perhaps the farm operator should think in terms of some irrigation every year unless the rainfall in a particular season is so great that additional water would be detrimental to the crops and to the land. Perhaps the farm operator should think in terms of combining his inputs every year in relation to the maximum amount of moisture he can utilize in view of the physical characteristics of his soil. Rubey notes that many farmers hesitate to use certain fertilizers because it is thought they tend to "burn out" a crop which is inadequately watered.[24] It seems very probable that fertilizers and higher-yielding crop varieties have been utilized in some areas until water is now the limiting factor preventing further increases in production. Certainly, the farm operator should give serious consideration to this problem before stacking his portable irrigation system in the shed to be used once in several years.

The Need for Technical Assistance

Small individual and group irrigation projects face problems peculiar to that type of development. Among the most important is the availability of technical assistance in the design and operation of the irrigation systems. Small-scale developments do not have available the technical help that is an important part of larger projects. As a result, many small irrigation projects are not efficiently designed from an engineering standpoint. Hampton noted: "The large portion of irrigation costs due to depreciation, interest, and other first costs of investment indicates the full importance of a well designed system." [25]

Irrigation systems in humid areas are generally private and individual undertakings. The following are suggested as questions the farm operator must answer before installing an irrigation system: Is the soil capable of being irrigated? What is the extent and quality

[24] Rubey, *op. cit.*, p. 9.

[25] R. N. Hampton, R. G. Murphy, and P. R. Hoff, *Potato Irrigation: Costs and Practices in Suffolk County, New York, 1946*, Cornell University Agricultural Experiment Station Bulletin 862, September, 1950, p. 39.

of the water supply? What will be the cost of installing the system? What can be expected in the way of gains in yields and quality? Will the system assure a crop even when the weather is dry? [26]

Research information adequate to provide the answers to these questions is lacking in many areas. Research studies concerned with humid-area irrigation are being initiated and expanded in many states. Results of these studies will provide a basis for expanded technical assistance to farm operators.

There are several sources of technical assistance available to the farm operator planning the installation of an irrigation system. County agricultural agents may be able to help the prospective irrigator. Many of the builders of portable irrigation systems provide excellent engineering advice. Some states in the humid area employ one or more irrigation specialists in the Agricultural Extension Service. In some areas, technical assistance in planning irrigation developments is available through the Soil Conservation Service and Soil Conservation Districts. Increasing emphasis is being placed on problems of irrigation in Soil Conservation Districts in states of the humid area.[27]

The Role of Public Agencies

The activities of the Bureau of Reclamation of the U.S. Department of the Interior are limited to the seventeen western states plus Arkansas and Louisiana. What should be the role of public agencies with respect to irrigation development in states of the humid area? Should there be any programs by state or federal agencies or should irrigation development be left entirely to private effort? Rubey stated:

> The advancement of supplemental irrigation will best be accomplished through the interest and efforts of groups and organizations, as has been the case in most older successful irrigation developments, rather than by individuals. Modified organizational procedures that will give benefits comparable to those that have been realized in arid regions must be established in humid and sub-humid regions.[28]

[26] Dick Hanson, "Irrigation: The Midwest's Newest Help," *Successful Farming,* XLVIII, No. 8 (August, 1950), 44–78.

[27] Hugh Bennett, "The Use of Water in Humid Areas," *Soil Conservation,* XVII, No. 5 (December, 1951), 99–103.

[28] Rubey, *op. cit.,* p. 58.

Some consideration has been given recently to multiple-purpose development in states of the humid region. Serious consideration has been given to irrigation in the Altamaha Basin Project in middle and east Georgia.[29] Preliminary data indicated that the increased value of crops resulting from irrigation would amount to $25,000,000 annually on about 464,000 acres of land. Low-cost electrical energy, produced by power plants on the project, would be utilized to operate the irrigation pumps.[30]

The extent to which public development of irrigated lands may be expected on the pattern of that in the western states is uncertain. In those areas where multiple-purpose projects may be feasible, public irrigation development is likely to be a part of the development if the land-water resources are appropriate. The role of public agencies, however, is more likely to be in the direction of aid to private developments. It is possible that it may be judged in the public interest in the future to provide subsidies for supplemental irrigation. Experimental and demonstration farms may be an important adjunct to the expansion of irrigated acreage in humid areas.[31] The most important role of public agencies will, in all probability, be in the field of education and technical assistance. There are, however, several important proposals for great expansion of irrigation in subhumid areas through public development. Among the most significant of these plans are those for the Willamette Valley in Oregon and the lower or eastern portion of the Missouri River Basin. In the Missouri River Basin, for example, it is proposed to irrigate 750,000 acres of land in one block on the fringe of the Corn Belt in eastern South Dakota.[32]

It is characteristic of subhumid lands proposed for irrigation that they are all now in agricultural use and that private irrigation development has been relatively small. Irrigation development in subhumid areas faces most of the problems found in the irrigation of semiarid lands as well as some additional ones. Joss has listed the outstanding difficulties facing subhumid irrigation development: [33]

[29] Everett H. Davis, "A State Irrigation Program," *Agricultural Engineering,* XXVIII, No. 9 (September, 1947), 416–17.

[30] Davis, "Irrigate for More Profits," *op. cit.*, p. 19.

[31] Rubey, *op. cit.*, p. 56.

[32] Senate Document 191, 78th Cong., 2d sess., 1944, *Missouri River Basin: Conservation, Control and Use of Resources,* pp. 115–16.

[33] Alexander Joss, "Benefits from Irrigation Under Sub-humid Conditions," *Journal of Farm Economics,* XXVIII, No. 2 (May, 1946), 543–59.

1. So little irrigation currently is practiced in these subhumid areas that it is difficult to obtain factual data on which to base benefit computations.

2. Most of the irrigable land in subhumid areas is now in private ownership and in agricultural use. Many of the farms embrace large acreages. With irrigation these larger holdings may need to be broken up. Total incomes of certain individual farm operators may actually be less with irrigation than without it even though incomes per acre will be greater.

3. The problem of forecasting the portion of the irrigable acreage that actually will be irrigated each year is likely to be extremely difficult in subhumid areas. In the twenty-two oldest Bureau of Reclamation projects the acreage in cultivation in 1942 was only 78 per cent of the area termed irrigable by the Bureau. Most of these projects had been irrigated for thirty years, and many of them are located in arid and semiarid portions of the West. It seems highly probable that the new developments in the subhumid areas will not average so high a proportion of the irrigable land actually irrigated in any one year because of the possibilities for growing nonirrigated crops.

4. The costs of some of the projects proposed for the subhumid area are high compared with costs of previously developed areas.

5. An adequate method of calculating benefits has not been developed. The "gross value of crops" method tends to overstate benefits by not making adequate allowance for alternative uses of the production factors involved; i.e., the opportunity costs are not considered.

6. Benefits from irrigation under subhumid conditions are likely to be small. This is not because the land in these areas is necessarily less productive under irrigation than land in the arid regions but because its production without irrigation narrows the spread between irrigated and nonirrigated output.

7. Unless a portion of the benefits accrues to present owners, there is no incentive for them to undertake irrigation or to sell their property to prospective irrigators. There is reason to believe that this incentive must be larger in subhumid areas than was the case in arid regions. The portion of the benefits thus accruing to present landowners is not available for repayment of the costs of the project.

The Benefits of Humid-Area Irrigation

Research data are scarce regarding the benefits to be derived from irrigation in humid areas. In view of the individual nature of such irrigation development, the determination of feasibility is largely a matter of the effect on the individual farm. Whether or not irrigation should be undertaken on a particular farm involves the same type of decision as the farm operator faces in adopting new cropping practices, buying new farm machines, or establishing new farm enterprises.

A considerable number of reports of individual farm experiences have been published in periodicals. In addition, a lesser number of research bulletins are available. With respect to specialty crops, a number of results will be noted. An Ohio fruit grower stated that he had not had a strawberry crop failure in fourteen years of irrigating and estimates he produced 75 per cent more berries in 1948 than would have been possible without irrigation.[34] A Pennsylvania apple orchard yielded 1,000 packed boxes per acre at an irrigation cost of three and one-half cents per box for 12 inches of water.[35] The increase in size and color of a peach crop paid for an irrigation system in one season.[36] A Michigan farm doubled squash production by irrigation.[37] An Ohio report showed a yield of 5,560 quarts of strawberries per acre from irrigated plants as compared with 2,940 quarts from nonirrigated plants. This increase in yield was equal to a gain of $786 per acre if the berries were sold at 30 cents per quart.[38] A Massachusetts vegetable farmer will include 50 acres of irrigated alfalfa for rotation and soil building purposes from which he expects to get six tons of alfalfa to be marketed as baled hay.[39] A New York research study showed that potato producers realized average yield increases of almost 60 bushels per acre during

[34] Eldon S. Banta, "Water Makes the Berries," *American Fruit Grower*, June, 1949.

[35] "Big Juicy Apples," *American Fruit Grower*, June, 1949.

[36] A. M. Musser, "Does Peach Irrigation Pay Off?" *American Fruit Grower*, August, 1948.

[37] Harry L. Spooner, "Irrigation Doubles Squash Production," *Market Growers Journal*, LXXVIII, No. 3 (March, 1949).

[38] Wesley P. Judkins, "Irrigation for Strawberries," *Farm and Home Research* (Ohio Agricultural Experiment Station), XXXII, No. 246 (May-June, 1947).

[39] Walter E. Piper, "Irrigation Pays," *Market Growers Journal*, LXXIX, No. 11 (November, 1950), 12–15.

a period when New York potatoes sold for an average of more than $1.10 per bushel. When compared with the average cost of irrigating potatoes of $33 per acre, a substantial profit is indicated from irrigation.[40] A research study of potato farms in Wisconsin and Michigan showed substantial increases in yields as a result of irrigation. On sandy soils, potatoes yielded from 350 to 400 bushels per acre with irrigation as compared with yields of 125 to 150 bushels per acre without irrigation. On heavier soils, yields of 300 to 500 bushels per acre were obtained with irrigation and only 200 to 300 bushels without irrigation.[41]

There are fewer results available for field crops under irrigation in humid areas. Strohm reported on a Michigan farmer who increased his corn yield 400 per cent with irrigation and an Illinois farmer who expected to pay for an irrigation system in one year by using it on corn.[42] Research results on three crops were reported in Arkansas and are shown in Table 10.

TABLE 10

Crop Yields on Irrigated and Nonirrigated Rice Soils in Arkansas

Treatment	Average Yield for Nine Years		
	Cotton (lbs..)	Soybeans (bu.)	Corn (bu.)
Unirrigated and unfertilized	233.1	11.6	11.6
Irrigated	319.3	14.3	12.2
Fertilized	508.5	13.0	19.8
Irrigated and fertilized	698.5	15.5	21.8

Source: R. P. Bartholomew, L. C. Kapp, and Martin Nelson, *Irrigation of Arable Crops on a Rice Soil,* Arkansas Agricultural Experiment Station Bulletin 455, June, 1945.

The irrigation of pastures in humid areas is a comparatively new practice. Pasture has been, on most farms, the poorest land on the farm, whereas the present-day trend is to select pasture mixtures seeded on the most fertile cropland on the farm.[43] The North

[40] Hampton, Murphy, and Hoff, *op. cit.*, p. 46.

[41] Emil Rauchenstein, "Irrigation of Potatoes in Wisconsin and Michigan," U.S. Department of Agriculture, Bureau of Agricultural Economics, in cooperation with Wisconsin Agricultural Experiment Station (mimeographed), December, 1947.

[42] John Strohm, "Profits from Pipelines," *Country Gentleman*, September, 1949.

[43] J. Sidney Cates, "Modern Pastures Outyield Grain," *Country Gentleman*, September, 1949.

Carolina Experiment Station reported that cattle on this type of improved pasture made gains equivalent to that provided by a 75-bushel-per-acre corn yield and the pasture was on land that normally produced 25 bushels per acre.[44] An Oregon dairyman was able to pasture 70 head of mature and young stock, including his milking herd of 50 cows, on 30 acres of irrigated pasture from April until late October.[45] The use of irrigated pastures is spreading in many farming areas of different types and promises to bring about significant changes in the agriculture of some areas.

In addition to gains in crop yields and the carrying capacity of pastures, other benefits may be associated with portable irrigation systems. These benefits are the result of specialized uses of the irrigation system. Peikert lists five uses as follows:[46]

1. Applying commercial fertilizer
2. Protection against frost
3. Drainage of low places in fields where there is no outlet
4. Farmstead fire protection
5. Applying insecticides and herbicides

These additional uses of a portable irrigation system will influence not only the production of crops but will also reduce cash costs and labor requirements for some farm operations and spread the investment involved over a wider range of utilization.

The Conflict for Water

The expansion of irrigation in humid areas has intensified the competition for water in many areas. The humid areas have the greatest density of population and the heaviest demand on the water supply for nonagricultural uses. A large part of the water used in the humid areas comes from ground-water sources. Pumping of water from wells in the United States doubled in the period 1935–45, from 10 billion gallons of water per day to 20 billion gallons of water per day. The importance of irrigation in this tremendous consumption of water is indicated by the fact that, of the 20 billion gallons used, irrigation accounted for 10 billion gallons; industrial

[44] Cates, *op. cit.*
[45] William G. Schulz, "June Grass in August," *Country Gentleman*, July, 1947.
[46] F. W. Peikert, "Irrigation with Sprinklers and Portable Pipe," *Agricultural Engineering*, XXIX, No. 12 (December, 1948), 541–44.

uses, not including water supplied from municipal systems, totaled 5 billion gallons; municipal uses were 3 billion gallons; and other rural uses, not including irrigation, were 2 billion gallons.[47]

The heavy drain on ground-water supplies has created considerable alarm in many areas and brought demands for more effective controls of the use of ground waters. Wells and Williams take a moderate view of the situation. While acknowledging that the situation is serious in some areas, they state: ". . . despite the rather widely accepted belief that runoff and ground-water levels are declining, hydrologic data including stream flow, ground-water levels, and precipitation records, have so far failed to indicate any widespread downward trends."[48]

Irrigation in humid areas is concerned with surface waters as well as ground waters. With respect to surface waters, modification of existing law appears necessary if irrigation development is to move forward. Constitutional amendments may be necessary in order to make possible the desired changes in the riparian water rights.[49] Whitaker and Ackerman suggest:

> Another doctrine is involved in efficient use of irrigation water—that of equality of right to water in watercourses, established by the Supreme Court (1931) with respect to interstate water problems in eastern United States. The doctrine is akin to the doctrine of correlative rights in that it aims at an equable distribution of water among the various claimants. As irrigation expands in humid areas, the doctrine of riparian rights will be less and less appropriate; it may be that the doctrine of equable distribution is to serve in the East as the doctrine of prior appropriation for beneficial use has served in western United States.[50]

Any proposal to change or modify the law with respect to the rights to water must immediately come in conflict with established rights. In 1907, South Dakota undertook to substitute the doctrine of prior appropriation for that of riparian rights. The Supreme

[47] H. W. Lull and E. N. Munns, "Effect of Land Use Practices on Ground Water," *Journal of Soil and Water Conservation*, V, No. 4, Part I (October, 1950), 169–79, 196.

[48] Joseph V. B. Wells and Adrian H. Williams, "The Water Situation in the United States," *Journal of Soil and Water Conservation*, VI, No. 2 (April, 1951), 78–82, 100.

[49] Israelsen, *op. cit.*, p. 358.

[50] J. Russell Whitaker and Edward A. Ackerman, *American Resources; Their Management and Conservation* (New York: Harcourt, Brace & Co., Inc., 1951), p. 164.

Court held the legislation to be unconstitutional, saying that the riparian right was a vested property right and that such property rights in the state could not be confiscated or interfered with by any such act of the legislature.[51] In Michigan, where supplemental irrigation is expanding rapidly, proposed legislation would extend the right to use water to those not having riparian rights and, at the same time, protect the rights of the riparian landowners. The proposed legislative act is based on the assumption that the rights of riparian owners are qualified and need not extend to the entire surface-water supply. The limitation involves application of the doctrine of beneficial use, which is the core of the western appropriation doctrine. Any water over and above the amount which can be used beneficially by riparian owners should be available for appropriative use. Three classes of water rights would be established by the proposed act. All riparian owners would be recognized as having class A rights, i.e., vested rights. Water users who are now making beneficial use of water would be awarded class B vested rights. Farm operators and others, whether riparian owners or not, who do not qualify for class B rights, may file appropriation applications with the State Water Resources Commission. The Commission is to record applications in the order of priority, review them, and hold hearings if deemed advisable or if requested by interested persons. If applications for appropriation rights meet the requirements of the law, involve reasonable use, and do not impair the rights of class A or class B users or the rights of prior appropriators, the Commission is required to issue appropriation permits for stated volumes of water.[52] This type of legislation may provide a usable pattern for modifying water rights in states of the humid area and make possible the efficient utilization of the available water supply.

[51] Kenneth Raschke and Kris Kristjanson, "South Dakota Water Law Principles and District Organization," A special report presented to the State Committee on Water Law Legislation and the South Dakota Coordinating Committee for Missouri Basin Development, Pierre, S.D., October 25, 1950.

[52] Raleigh Barlowe, "Proposed Water Rights Legislation in Michigan," *Land Economics*, XXVI, No. 3 (August, 1950), 300–5.

CHAPTER 15

Irrigation Development in Relation to Population Trends and Food Requirements

The demand for agricultural production is dependent upon population and the kind and quantity of food and fiber consumed by that population. The supply of agricultural products is dependent upon the available lands and the technology which may be applied to make those lands more productive. This chapter is concerned with the demand for the production from agricultural lands. The next chapter will be devoted to alternatives for supplying the necessary agricultural production.

The past decade has witnessed the publication of a large number of magazine articles and books having to do with world population and the food situation.[1] This group of writers has been labeled Neo-Malthusians by those individuals having a considerably different opinion regarding the population-food problem. The label of Neo-Malthusian is associated, of course, with the writings of Thomas Robert Malthus (*Essay on Population,* 1798) in which he argued that the population tends to outrun the food supply. Many persons contend that the world is about to experience the proof of this dismal doctrine.

It is impossible to determine accurately the population of the earth because a number of countries do not take a census; it was estimated that world population was approximately 2.3 billion human beings in 1950.[2] If the world population continues to grow as it has in the past three hundred years, in another three hundred

[1] Among the better known books are the following: Henry Fairfield Osborn, *Our Plundered Planet* (Boston: Little, Brown & Co., 1948); William A. Vogt, *Road to Survival* (New York: William Sloane Associates, Inc., 1948); Frank A. Pearson and Floyd A. Harper, *The World's Hunger* (Ithaca, N.Y.: Cornell University Press, 1945); E. Parmalee Prentice, *Food, War and the Future* (New York: Harper & Bros., 1944).

[2] William F. Ogburn and Meyer F. Nimkoff, *Sociology* (2d ed.; Boston: Houghton, Mifflin Co., 1950), p. 302.

years the population will be nearly 8.5 billion and by 2500 it will be nearly 25 billion.[3] Of more immediate import are estimates regarding the future population possibilities of India and China. On the basis of past experience, China will double her 400 million in ninety-nine years but, with peace and rapid economic development, she could treble her population in that time.[4] If India's death rate could be lowered to the level of that of the United States and the present birth rate continued, that country could fill five earths as full as ours in a single century.[5] The level of education and information which would be associated with a lowering of the Indian death rate to the level of that in the United States would, almost certainly, bring an increase in birth control. For the short run, however, a decrease in the death rate, and particularly a reduction in the mortality rate among babies, could bring a tremendous increase in population in a country such as India.

Geographers estimate that man needs 2.5 acres of arable land per person to feed and clothe himself. On that basis, the world as a whole is already overpopulated. The estimated 4 billion acres of arable land in the world would support only 1.7 billion people. The United States had approximately 3.5 acres of arable land per person in 1950. Does this mean that the United States is approaching the dangerpoint in her ability to feed and clothe her population? The Neo-Malthusians are most concerned with world population trends, but they also argue that the United States will soon face perplexing population-food problems. There are certain criticisms to be made of the use of the ratio 2.5 acres of arable land per person as a uniform determinant of the ability of land to support population. It ignores the gains which have been made and which will continue to be made in the production realized from a given amount of resources. Indeed, the 2.5 ratio may bear little relation to the ratio ultimately achieved under the most advanced conditions of technology. The tendency of the alarmist writers on population-food problems to ignore or minimize the potentialities of technology has, unfortunately, caused many persons to take a skeptical view of a very serious problem.

[3] *Ibid.*, p. 327.

[4] C. Lester Walker, "Too Many People," *Harper's Magazine*, February, 1948, pp. 97–104.

[5] Guy Irving Burch, "Conservation and Population," *American Forests*, LV, No. 11 (November, 1949), 13, 43.

Malthus concerned himself in his writings with only two factors (population and food) and many of his modern followers have not taken a much broader viewpoint. The ability of resources to support population, and the standard of living attained, are functions of four variables rather than two. They are (1) the natural resources available, (2) the level of technology, (3) the economic and social organization, and (4) the population. Economic and social organization includes such things as division of labor, the productivity of labor, the money and credit system, and the amount and kind of trade.

With respect to irrigation development and public water policy, we are most concerned with total and regional population-food trends in the United States. The population-food problem in the United States, however, cannot and should not be divorced from the world situation. This phase of the total problem will be discussed in a later chapter.

National Population Growth

The growth in the population of the United States during the 1941–50 decade was much larger than expected. The census count of 131,669,000 persons in 1940 had increased to 150,697,361 in the 1950 census, a gain of almost 15 per cent in ten years. The rapid rate of increase has continued since 1950, as indicated by a Bureau of the Census estimate that the population had reached almost 158,500,000 on January 1, 1953.

The population specialists of the United States were greatly in error in their estimates of the 1950 population when they viewed the prospects during the 1930's and 1940's. These same students of population are making further projections for the future which appear overly conservative, to say the least. In view of the extreme error in the work of this group in the past, it would appear desirable that projections of future population be examined most carefully.

Joseph S. Davis of the Food Research Institute at Stanford University has prepared an excellent study of the current population situation in the United States in which he states:

> Our population upsurge is of fundamental and far-reaching importance, to a degree that is only beginning to be recognized. The developments in the 1940's have been strikingly at variance with confident

expectations, based on extended research by scholars of high repute. Furthermore, the population prospect for the decades ahead is radically different from the picture that has continued to be widely accepted.[6]

Dr. Davis gave particular attention to the forecasts of Raymond Pearl and Lowell J. Reed of Johns Hopkins University and Warren S. Thompson and P. K. Whelpton of the Scripps Foundation. Thompson and Whelpton published a series of projections based on various assumptions in a 1938 report to the National Resources Committee. Davis noted: "The three highest projections, all of which now appear too low in comparison with postcensal estimates for the 1940's, . . . seem not to have been taken seriously by the Committee or their real authors."[7] It is also noted that the Census Bureau, in mid-1941, took the projection which Thompson and Whelpton had favored as its official forecast. This projection foresaw a population of slightly more than 140,000,000 in 1950 and a peak population of about 152,000,000 in 1980. Compare this with the 1950 census of more than 150,000,000 and the Census Bureau estimate of almost 158,500,000 on January 1, 1953.

Whelpton prepared another forecast of population in the United States which was published by the Bureau of the Census in 1947. Several projections were made on the basis of various assumptions of fertility, mortality, and immigration. The projection, which assumed high fertility, low mortality, and net immigration of 1,000,000 per five years, forecast a population of 155,126,000 in 1955 and 185,071,000 in 1975. Whelpton preferred a projection based on medium fertility, medium mortality, and net immigration of 1,000,000 per five years, which forecast a population of 156,775,000 in 1960 and 169,801,000 in 1975.[8] It is significant that, even on the basis of forecasting for a short period into the future from 1945, the actual population numbers had reached a point in six years (155,356,000 in 1951) almost equal to the forecast for the fifteen-year point (156,775,000 in 1960). The continued large error in forecasts by population specialists, even when made for a short time into

[6] Joseph S. Davis, *The Population Upsurge in the United States*, Food Research Institute, Stanford University, Stanford, Calif., December, 1949, p. 13.

[7] *Ibid.*, p. 20.

[8] P. K. Whelpton, *Forecasts of the Population of the United States, 1945–1975*, U.S. Department of Commerce, Bureau of the Census, Washington, D.C., 1947, p. 41.

the future, is grounds for considerable skepticism regarding the generally accepted ideas of future population growth in the United States.

With respect to the forecasts made by Pearl and Reed and first published in June, 1920, Davis noted that the Census figure for 1940 was so far below the forecast for that year as to cause the authors some concern while the 1950 census seemed certain to be above the Pearl-Reed forecast, though by a smaller margin than the 1940 figure was below theirs.[9] The Pearl-Reed forecast was based on a mathematical ("logistic") curve fitted to then available decennial population data from 1790 to 1910. The basic theory is that populations, including human populations, grow in size according to the same mathematical law that individual animals and plants follow in the growth of their bodies in size. Davis stated, "I cannot accept Pearl's conclusion that the 'major problems of population are primarily and fundamentally biological in nature,' though the biological basis surely looms large in the complex of factors that determine the size, composition, and quality of peoples." [10]

Population specialists are well-nigh unanimous in minimizing the long-run effects of the population upsurge of the past decade and in emphasizing its temporary nature and lack of significance. Hauser and Taeuber wrote, "This upturn in rate of population growth may be regarded as a temporary phenomenon resulting jointly from the period of boom prosperity which immediately preceded and followed the entrance of the United States into World War II and from the impetus given to marriage and fertility rates by the passage and administration of the Selective Service laws." [11] Thompson stated: "The writer believes . . . that the slower growth of our population will soon be resumed and that within two or three decades we shall not have even a crude natural increase, while the net reproduction rate may again fall below 100 within a few years. . . ." [12] Baker predicted that the population of the

[9] Davis, *op. cit.*, pp. 26–27.

[10] *Ibid.*, p. 72.

[11] Philip M. Hauser and Conrad Taeuber, "The Changing Population of the United States," *Annals of the American Academy of Political and Social Science*, CCXXXVII (January, 1945), 12–21.

[12] Warren S. Thompson, "The Demographic Revolution in the United States," *Annals of the American Academy of Political and Social Science*, CCLXII, (March, 1949), 62–69.

United States one hundred years hence would be much smaller than in 1947.[13]

Davis took issue vigorously with the failure to recognize the long-run implications of population trends in the United States. He said:

> To me now, a United States population rising to 300 million or more in the next half-century is easier to envision than upper limits of 150–165 million, which have been seriously suggested, well within 10 years, as our all-time peak of population. . . . Furthermore, I make bold to challenge the view—held by almost all demographers of all schools—that our population must, later if not sooner, reach a peak of any size, at any time, from which a decline is probable if not inevitable.[14]

Davis rejected several widely held views regarding population trends for the near future:[15]

1. That population forecasts for ten, twenty, or fifty years ahead cannot be far wrong;
2. That the recent or present age structure "inherently" points to cessation of population growth in a generation or so;
3. That, for all reasons combined, our population will inevitably reach a peak at which stabilization is possible but a decline probable, before 2000 or later;
4. That growth of the United States population so rapid as to double in fifty to one hundred years is certainly over;
5. That either the crude birth rate or age-specific birth rates must shortly fall below those of the 1930's and resume downward trends which were reversed in the 1940's;
6. That the population of elementary school ages will soon (within a decade) reach a peak from which a decline is highly probable if not sure;
7. That almost all the possible gains in life expectancy have already been achieved;
8. That the crude death rate must soon rise;
9. That past trends, if persistent through decades or more than a century, can be reasonably expected not to change.

Davis raised the question as to whether the population forecasters in the 1930's might have been more nearly right had they

[13] O. E. Baker, *The Population Prospect in Relation to the World's Agricultural Resources*, University of Maryland, College Park, 1947, p. 9.

[14] Davis, *op. cit.*, p. 69.

[15] *Ibid.*, p. 77.

foreseen our involvement in a six-year world war. He suggested that, on the contrary, the forecasters would have missed even more in view of the fact that, traditionally, war has been regarded as a population destroyer and depressant.[16]

Figure 3 illustrates the changed age and sex distribution of the population of the United States. The pyramids for 1940 and 1950 show clearly the effects of the economic depression of the 1930's and of the World War II period and the years following. The author of the article which accompanied these illustrations took a more moderate view of the long-run implications than other population specialists when he wrote:

> . . . on balance, it now seems that we should expect a considerable recession from the high birth rate of the 1940's before very long. It is unlikely, however, that we shall return to the low birth rates of the depression years in the foreseeable future, provided the marriage age stays young and the proportion of those who never marry does not increase. . . . Our population should therefore continue to grow, at a rate somewhat lower than that of the 1940's. But we are not in a position to make any precise estimates of our future size; there are too many unknown variables at work.[17]

When one looks at the base of the 1950 pyramid in Figure 3, it appears that there is solid ground for considerably more of a bullish viewpoint regarding the future trend of population in the United States.

Western Population Growth

Population trends are a function of fertility rates, mortality rates, and migration. The regional distribution of the population of the United States has changed greatly during the past half-century. These population shifts illustrate the effects of birth rates and migration. Among the major regions, the population of the South grew the most numerically; the population of the West, the most proportionately. The South had the highest birth rate, which offset the migration of people away from it. The low birth rate of the West was offset by the migration of people to it.

[16] *Ibid.*, p. 55.

[17] Frank W. Notestein, "Population," *Scientific American*, CLXXXV, No. 3 (September, 1951), 28–35.

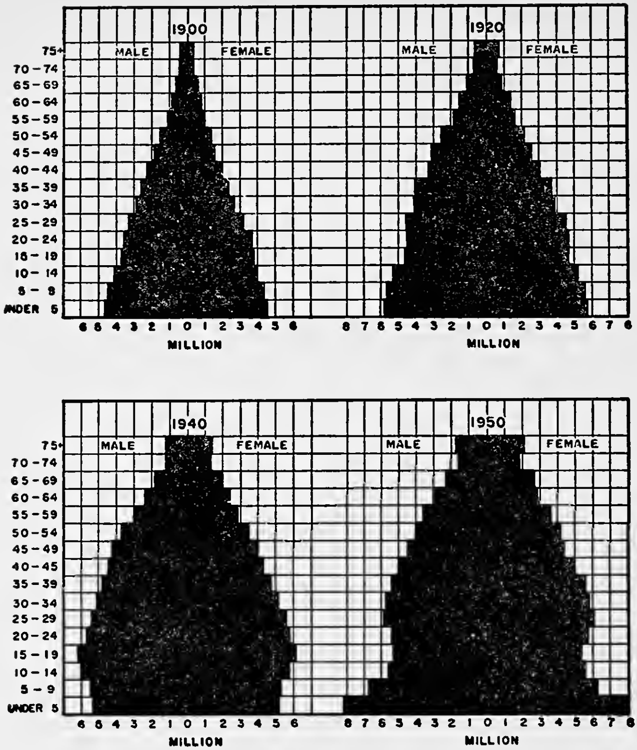

Figure 3. Age and Sex Distribution of the Population of the United States. (Frank W. Notestein, "Population," *Scientific American*, September, 1951.)

The South grew from a population of 24,523,000 in 1900 to 47,197,000 in 1950; a gain of 22,674,000, or 92 per cent. The West increased in population from 4,092,000 in 1900 to 19,562,000 in 1950; a gain of 14,470,000, or 353 per cent. The North Central region saw a population increase of 68 per cent while the population of the Northeast region grew 87 per cent during the half-century.

Of particular significance to questions of irrigation development is the large population growth of the West during the 1940's. The population increases of the seventeen reclamation states are shown in Table 11. California led all states with a gain of almost 52 per cent, i.e., a numerical increase of 3,582,683 over her 1940 population. The three Pacific Coast states of California, Oregon, and Washington increased their populations by a combined total of 4,632,197, approximately equal to the 1950 population of Massachusetts or New Jersey.

What are the prospects for continued population growth in the West? McWilliams expects the population of California to continue increasing at a substantial rate; he wrote:

> . . . California is still a very young state whose area is virtually limitless in comparison with its present population. California's present population density, per square mile of arable land (not counting mountains, desert, and forest), is still only one-eighth that of Massachusetts, the first state to be settled. The experts now forecast that California will show an additional gain of 2,650,000 in the 1950's, that it has not yet reached the mid-point in its growth, and that 20,000,000 people will eventually reside within its boundaries.[18]

TABLE 11

POPULATION CHANGES IN THE SEVENTEEN WESTERN STATES

State	Population		Change	Per Cent of Change	
	1940	1950	1940–50	1930–40	1940–50
Arizona	499,261	745,259	245,998	14.6	49.3
California	6,907,387	10,490,070	3,582,683	21.7	51.9
Colorado	1,123,296	1,318,048	194,752	8.4	17.3
Idaho	524,873	585,092	60,219	17.9	11.5
Kansas	1,801,028	1,894,390	93,362	—4.3	5.2
Montana	559,456	587,337	27,881	—4.1	5.0
Nebraska	1,315,834	1,318,079	2,245	—4.5	.2
Nevada	110,247	158,283	48,036	21.1	43.6
New Mexico	531,818	677,152	145,334	25.6	27.3
North Dakota	641,935	617,965	—23,970	—5.7	—3.7
Oklahoma	2,336,434	2,223,650	—112,784	—2.5	—4.8
Oregon	1,089,684	1,512,100	422,416	14.2	38.8
South Dakota	642,961	650,029	7,068	—7.2	1.1
Texas	6,414,824	7,677,832	1,263,008	10.1	19.7
Utah	550,310	686,797	136,487	8.4	24.8
Washington	1,736,191	2,363,289	627,098	11.1	36.1
Wyoming	250,742	288,800	38,058	11.2	15.2

Source: Bureau of the Census.

A projection of regional population distribution suggests three series of forecasts for the Pacific Coast states. The low series forecasts a population increase by 1960 of 14 per cent over the 1950 total for California, Oregon, and Washington, the medium series forecasts an increase of 26 per cent; and the high series, an increase of

[18] Carey McWilliams, "Look What's Happened to California," *Harper's Magazine*, October, 1949, pp. 21–29.

34 per cent.[19] The increase of 26 per cent forecast in the medium series is approximately the same percentage increase as suggested by McWilliams for California during the 1950's. The forecast for 1975 is 21 per cent above the 1960 forecast or 53 per cent over the 1950 population of the three Pacific Coast states.[20]

Western farmers and ranchers have an advantage in supplying the growing demand for farm products in the West. This is illustrated in a study by Selby and Griffith which indicates that the eleven western states are likely to be a dwindling source of supply of beef cattle and sheep for the rest of the country, even with a maximum rate of irrigation development, if western population increases relative to national population as in the past, and if there is no material decrease in consumption of meat per capita.[21] Figure 4 illustrates the statement, "As the number of beef cattle needed for western population has increased, and the number available for eastern markets has decreased, points at which cattle are shipped westward rather than eastward have been shifting eastward." It is further suggested, "It appears possible that by 1970 a very small net amount of beef cattle, if any, will be available for shipment eastward from the 11 Western States. It is probable, however, that shipment of feeder cattle out of the region would continue, offset to an increasing extent by inshipment of dressed beef." [22] A similar shift is occurring in the lines of balance between eastward and westward shipment of sheep.

In addition to the effect of increased consumption of meat in the West itself because of a larger population, there has been some decline in the importance of the West as a source of meat animals as a result of long-run reduction in the carrying capacity of the range. Heavier stocking has taken place during the past decade of favorable conditions of precipitation and it remains to be seen whether the constantly improving programs for conservation of the range will offset further deterioration.[23] At the same time, the

[19] Margaret Jarman Hagood and Jacob S. Siegel, "Projection of Regional Distribution of Population," *Agricultural Economics Research,* III, No. 2 (April, 1951), 41–52.

[20] *Ibid.*

[21] H. E. Selby and Donald T. Griffith, *Livestock Production in Relation to Land Use and Irrigation in the Eleven Western States,* U.S. Department of Agriculture, Bureau of Agricultural Economics, Berkeley, Calif., March, 1946, p. 17.

[22] *Ibid.,* p. 15.

[23] *Ibid.,* p. 9.

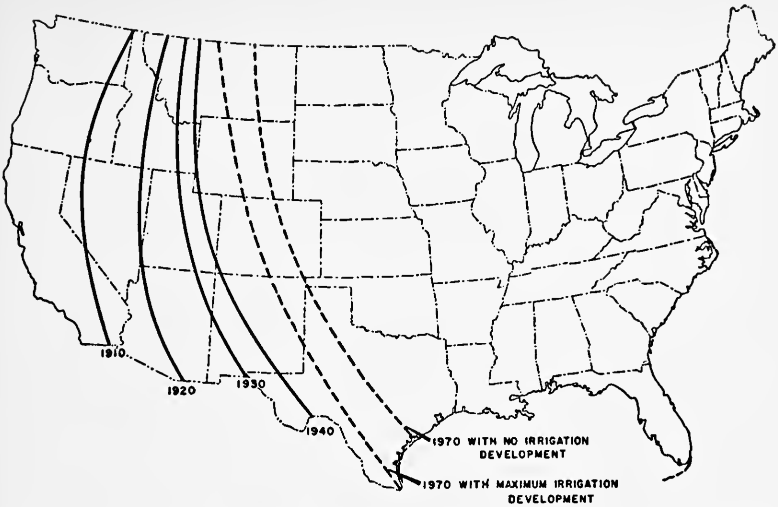

FIGURE 4. Approximate Lines of Balance Between Eastward and Westward Shipment of Beef Cattle. (H. E. Selby and Donald T. Griffith, *Livestock Production in Relation to Land Use and Irrigation in the Eleven Western States,* U.S. Department of Agriculture, Bureau of Agricultural Economics, p. 15.)

national demand for meat has increased as a result of an increasing population in the nation as a whole. Both population growth in the western states and the ability of the resources of the region to produce for that population, as well as to contribute to the food and fiber needs of the nation, are important factors in questions of public policy with respect to irrigation development.[24]

Higher Levels of Nutrition

Increased food requirements and the resultant effect on agricultural resources are dependent on more than numerical increase in population. Food requirements are also dependent on what people eat and how much. The general trend toward higher levels of nutrition in the United States is primarily one of consuming increased amounts of the farm products which require more land per capita than does the production of a cereal diet. The trends in per capita consumption of foods by major food groups are shown in Table 12. Substantial increases during the past forty years are shown for dairy

[24] See Marion Clawson and Wendell Calhoun, *Longterm Outlook for Western Agriculture,* U.S. Department of Agriculture, Bureau of Agricultural Economics, and U.S. Department of the Interior, Bureau of Reclamation, Berkeley, Calif., June, 1946.

TABLE 12

PER CAPITA CONSUMPTION OF FOODS, BY MAJOR FOOD GROUPS, 1909–49 [a]

Year	Total Food	Dairy Products	Meats, Poultry, Fish	Eggs	Potatoes [b]	Beans, Peas, Nuts	Fats and Oils [c]	Flour and Grain Products	Sugar and Syrups	Fruits	Vegetables	Coffee, Tea, Cocoa
1909	99	89	118	97	142	62	88	137	76	75	76	74
1910	96	86	113	102	144	62	85	137	78	74	72	70
1911	97	84	116	110	117	59	89	133	80	82	70	67
1912	98	92	112	103	132	61	87	133	79	85	77	79
1913	96	90	110	101	134	58	90	134	83	73	74	68
1914	97	88	108	98	119	62	96	136	82	88	74	71
1915	96	89	104	104	134	58	95	130	79	87	76	79
1916	95	89	106	100	108	54	94	134	80	78	73	85
1917	95	90	104	94	119	68	85	135	80	78	74	96
1918	97	94	108	94	129	78	97	123	82	72	77	84
1919	98	92	107	101	120	68	96	132	97	79	78	84
1920	97	94	105	100	115	84	89	121	94	89	82	85
1921	95	96	102	100	118	66	89	117	92	74	73	85
1922	99	97	105	105	120	74	95	119	108	88	78	87
1923	101	96	111	109	126	74	103	116	95	87	78	94
1924	102	98	111	108	112	89	101	115	104	91	83	89
1925	100	100	108	106	109	88	101	113	106	86	83	81
1926	102	101	107	113	98	89	99	115	106	100	83	91
1927	101	100	105	114	110	94	100	115	106	87	86	87
1928	101	100	102	113	113	94	105	118	108	95	84	85

Year	Total Food	Dairy Products	Meats, Poultry, Fish	Eggs	Potatoes [b]	Beans, Peas, Nuts	Fats and Oils [c]	Flour and Grain Products	Sugar and Syrups	Fruits	Vegetables	Coffee, Tea, Cocoa
1929	102	101	101	112	115	95	107	116	101	93	91	89
1930	101	100	101	110	100	98	105	114	112	88	90	88
1931	100	99	99	111	105	87	102	111	103	100	90	92
1932	98	98	100	104	110	92	101	105	98	83	91	90
1933	98	97	104	99	106	89	103	102	100	83	87	93
1934	99	96	109	96	107	90	100	101	100	83	89	87
1935	96	97	95	94	112	88	91	99	100	95	96	96
1936	99	99	103	96	99	102	99	102	103	94	94	99
1937	100	101	99	103	97	100	100	99	99	101	100	95
1938	101	100	99	103	100	108	102	100	98	99	105	103
1939	104	103	104	104	92	102	108	100	101	111	105	106
1940	106	104	108	106	95	105	114	98	97	111	105	110
1941	109	107	112	104	96	110	114	100	105	112	110	114
1942	109	113	112	105	97	117	106	104	98	103	117	93
1943	109	107	119	115	100	108	116	109	91	94	109	87
1944	112	110	122	116	96	100	117	102	99	106	110	105
1945	114	116	122	132	95	108	105	105	83	111	123	111
1946	119	124	123	124	95	119	114	100	85	125	127	130
1947	115	118	124	126	90	106	113	92	101	121	115	117
1948	111	111	117	129	81	101	115	89	96	114	116	120
1949	111	111	117	126	79	107	116	90	96	109	114	124

[a] Per capita consumption of food, retail weight equivalent, weighted by average retail prices for the base period, 1935–39. Consumption for total population 1909–40; civilian only, beginning 1941. Data for 1949 are preliminary.

[b] Including sweet potatoes. [c] Excluding butter.

Source: Adapted from Table 23 of *Consumption of Food in the United States, 1909–48*, Miscellaneous Publication 691, U.S. Department of Agriculture, Bureau of Agricultural Economics, Washington, D.C., August, 1949, and *Supplement for1949*, September, 1950.

products; eggs; beans, peas, and nuts; fats and oils; sugar and syrups; fruits; vegetables; and coffee, tea, and cocoa. Large decreases in per capita consumption are shown for potatoes and for flour and grain products. Consumption of meats, poultry, and fish has declined from the World War II high of 1946 to a level about the same as the per capita consumption forty years ago. Other food groups for which per capita consumption has decreased from high points attained during World War II are dairy products, fruits, and vegetables. It should be emphasized that the data in Table 12 are for the civilian population only and are not biased by military consumption during World War II.

It is shown, also, in Table 12 that per capita total food consumption is about 12 per cent higher than it was forty years ago. What does such an increase in consumption tell us regarding the adequacy of the national diet? Are there other factors to be considered in evaluating the meaning of the nutritional gains of recent years? Phipard points out:

> . . . To the casual observer, productive farms, well-stocked warehouses, and flourishing markets may indicate a well-fed nation. Indeed, average per capita consumption figures would seem to bear this out. It is only by a study of individual family food consumption that we can learn about deviations from the average and how significant these deviations are in terms of human nutrition.[25]

With reference to a 1936 study of diets in the United States, it is noted:

> Results of the 1936 study indicate that fewer than a fifth of the families in this country had diets that met the National Research Council's recommendations for each of the seven nutrients considered (protein, calcium, iron, vitamin A, thiamine, riboflavin, and ascorbic acid). Farm families fared better than city families on the average because the foods they produce at home—milk, eggs, meat, vegetables, and fruit—are good sources of the nutrients often found to be low in family diets.[26]

With respect to the same study, Black and Kiefer pointed out that the "allowances" recommended by the National Research Council are not "requirements" but rather should be looked upon as practical working goals. The recommended allowances are de-

[25] Esther F. Phipard, "How Good Is Our National Diet?" *Annals of the American Academy of Political and Social Science,* CCXXV (January, 1943), 66–71.
[26] *Ibid.*

scribed as sufficient to maintain freedom from deficiency diseases that can be determined only by medical or clinical tests, with liberal additions as safety factors to take care principally of the circumstance that a large fraction of the population has already accumulated chronic deficiencies that need to be corrected and that this calls for extra intakes over a long period.[27] Obviously, all families failing to meet the recommended allowances are not malnourished in the usual sense of the word. There is no uniform agreement among scientists regarding an optimum level of nutrition. Black and Kiefer said:

> . . . any standards set much higher than 65 to 70 per cent of the recommended allowances, except for calories, must be considered as approaching optimum rather than clinical standards. Perhaps for a population as well fed as that of the United States, 75 per cent of the recommended allowances is a reasonably high working standard, except for the nutrients required for growth, pregnancy, and lactation. A somewhat higher standard would be needed for a population with a large backlog of deficiency states to be corrected.[28]

An exact determination of the optimum level of nutrition is not, however, the important point in the population-food problem as it relates to the use of agricultural resources. The significant fact that is evident from the work of scientists in the field of nutrition is the existence of inadequacies in the diets of people toward the upper end of the nutritional scale. The inadequacies of diets among the low-income segment of the population is well known. Not so well recognized is the fact that a high-priced diet is not necessarily adequate in all respects. The greatest total benefits can be achieved by raising the nutritional level of those at the lower end of the scale. At the same time, correction of nutritional deficiencies among the high-income consumers may also have significant effects. The common national interest in better nutrition has been stated as follows:

> First and foremost: it makes better human beings, which is the principal object of civilization.
>
> Second: not only does it reduce greatly the amount of suffering and misery of people who are sick or half sick, but it increases incalculably the satisfaction and enjoyment in the experience of life.

[27] John Donald Black and Maxine Enlow Kiefer, *Future Food and Agriculture Policy* (New York: McGraw-Hill Book Co., Inc., 1948), p. 27.

[28] By permission from *Future Food and Agriculture Policy*, by John D. Black and Maxine E. Kiefer, p. 29. Copyright, 1948, McGraw-Hill Book Co., Inc., New York.

> Third: it increases the output of the individuals of society by making them more productive, and makes it possible for them to have more goods and services, or work fewer hours, or more likely, some of both.
>
> Fourth: it accomplishes this last result particularly by increasing the proportion of productive years in a lifetime. It broadens out the span of life in the working years around the prime of life.[29]

Pointing out that progress in nutrition affects the demand for food, Schultz wrote:

> With incomes and prices given, advances in applied nutrition make themselves felt in the economic sphere in two significant ways: (*a*) by changing the taste of consumers, and (*b*) by increasing the efficiency of food. The first of these may either increase or decrease the demand for food; the second, however, definitely points to a curtailment in demand. Nutrition as a movement has expressed itself thus far chiefly in measures, private and public, to close the nutritional gap. This movement has added to the demand for food. . . . Education may bring people to place a higher value on food, relative to other goods and services; even with incomes remaining constant, they would then choose to spend more of their incomes for food. The common belief is that more complete knowledge regarding nutrition will induce people to consume more of the expensive foods, costlier in terms of land, labor, and other resources required to produce them.[30]

What does improved nutrition mean in terms of policy for the use of agricultural resources? It goes without saying that the primary concern should be to secure the increases in consumption which are necessary to achieve nutritional goals and that increased production should be designed to fill the resultant increase in demand. Black has written: "The first step is deciding what goods must be consumed in larger quantities to improve diets in the ways most essential. The goals therefore will be consumption goals first, and production goals only as more or less ancillary thereto." [31] What is involved in achieving consumption goals? Cavin said:

> Actual food consumption depends upon the interplay of a considerable number of factors, among the more important of which are:

[29] National Planning Association, *A Food and Nutrition Program for the Nation*, Planning Pamphlet 46, May, 1945, p. 1.

[30] By permission from *Agriculture in an Unstable Economy*, by Theodore W. Schultz, pp. 70–71. Copyright, 1945, McGraw-Hill Book Co., Inc., New York.

[31] John D. Black, "Provision for Nutrition in the Formulation of Agricultural Programs," *Journal of Farm Economics*, XXX, No. 4 (November, 1948), 703–12.

> (1) size of the total national income and its distribution; (2) eating habits; (3) consumers' knowledge of the economics of food purchasing, including knowledge of dietary values, opportunities for food purchasing, and dietary values relative to costs; (4) prices of food which are a function partly of supply, partly of consumer buying power, and partly of the cost structure, particularly distribution costs.[32]

The consumption side of the problem can be affected by price ceilings, consumer rationing, food stamp plans, and distribution of surplus foods while the supply side can be influenced by price incentives, subsidies, better access to markets, and improved technology.[33] In addition, food habits may change because it is morally dictated, socially desirable, or scientifically sanctioned.[34] Education is also of great importance in achieving consumption goals and may be carried on through the schools, advertising, food marketing regulations, and motivation and persuasion based on considerations of health.[35]

It is obvious that food consumption goals will not be achieved by the application of nutritional science alone. Discussing the application of nutritional science to human welfare, Davis wrote:

> These applications call for the work of social scientists as well as of technicians of many kinds. As the focus of interest has broadened to include not merely individuals but groups, whole nations, and even mankind, nutrition has definitely spread into the field of social science and is already giving rise to increasingly numerous questions of social policy. Even nutritional science and practice stand to gain from the contributions of the social scientist and the well-advised evolution of public policy. . . .
>
> The study of the factors responsible for nutritional inadequacy, both in general and in particular, must be pushed farther back than biochemistry alone can push it, to the geographic, economic, sociological, psychological, and even political influences that contribute to it. These factors should be so analyzed as to be related to specific

[32] J. P. Cavin, "Agricultural Programs and the Nutritional Goal," *Food and Life, U.S. Department of Agriculture Yearbook, 1939*, pp. 396–402.

[33] C. Arnold Anderson and Mary Jean Bowman, "Methods of Controlling Food Consumption," *Annals of the American Academy of Political and Social Science*, CCXXV (January, 1943), 128–35.

[34] Margaret Mead, "The Factor of Food Habits," *Annals of the American Academy of Political and Social Science*, CCXXV (January, 1943), 136–41.

[35] Mary Jean Bowman and C. Arnold Anderson, "Nutrition Educational Programs," *Annals of the American Academy of Political and Social Science*, CCXXV (January, 1943), 150–57.

> forms of inadequacy rather than simply to over-all defect as compared with some more or less arbitrary composite "standard." . . .[36]

The attainment of nutritional goals does not imply only increases in the *volume* of agricultural production. The traditional emphasis in agriculture has been on higher yields but the quality of crops must be considered also. Kellogg pointed out: "The relation between soil conditions and physical development is more clear among animals and primitive human societies than in many modern groups. This we should expect, because people in the cities and others with good incomes obtain their foods from a wide variety of sources. . . . there is safety in having a wide variety of foods. . . ."[37] In this connection, it should be noted that the addition of "trace elements" to the soil has received increasing attention in recent years. Some dietary deficiencies have been found resulting from the absence of minor elements in the soils on which the food crop was produced.

Other ways in which the requirements of higher levels of nutrition can be met are through enrichment and fortification of certain foods and prevention of waste in the use of foods. It has been estimated, for example, that nearly one-fourth of the food produced in the United States is not utilized.[38]

Food and Feed Reserves

One other factor in the picture of total demand for agricultural production should be given at least brief consideration. Agricultural production varies considerably from year to year, primarily as a result of climatic factors. Especially favorable or unfavorable weather conditions tend to be localized or regionalized with the result that total agricultural production for the nation maintains a relatively stable level with respect to the effects of climatic factors. There have been two periods of extreme weather conditions, however, on an almost nationwide basis within the past quarter-century.

[36] Joseph S. Davis, "Nutrition, Social Science and Public Policy," *Annals of the American Academy of Political and Social Science*, CCXXV (January, 1943), 6–9.

[37] Charles E. Kellogg, "Soils and Nutrition," *Annals of the American Academy of Political and Social Science*, CCXXV (January, 1943), 17–21.

[38] Raymond P. Christensen, *Efficient Use of Food Resources in the United States*, U.S. Department of Agriculture Technical Bulletin 963, October, 1948, p. 23.

One was unfavorable and the other favorable. One was timed to create the least detriment and the other the greatest benefit to the nation. It is not difficult to imagine the increased complexity of the agricultural surplus problem if the depression of the 1930's had been coupled with the crop conditions of the 1940's. The outpouring of agricultural products would have multiplied the complexity of the agricultural problem several times. On the other hand, it is easy to picture how hard-hit the domestic and world food situation would have been if the World War II needs had been coupled with the drought conditions of the 1930's.

The preceding comments are not intended to form the justification for a public program of food and feed reserves. They are intended to emphasize the importance of taking the long view of the needs for the production from agricultural lands. Government purchase and storage of agricultural products should not be viewed as a solution for basic maladjustments in the pattern of agricultural production. Public policy, if any, with respect to food and feed reserves should be kept in the context of military needs and security requirements. It should be given appropriate consideration, along with population and nutrition trends, in appraising the food and fiber needs of the nation.

Moulton has pointed out the principal classes of commodities and services for which the public spends its money. He makes the following statement:

> Budgetary studies reveal that the great bulk of expenditures in the lower-income ranges goes for food, housing, and clothing. Through the middle- and higher-income brackets, the percentage spent for the basic necessities of life falls, while the proportion going for so-called conventional necessities and luxuries rises. Aggregate expenditures for food and nutrition increase at the successive higher levels, but the *proportion* spent for foodstuffs decreases progressively. Outlays for shelter and home maintenance increases more or less in proportion with incomes, while other types of expenditures rise much more than proportionally.[39]

The expenditures of the American people in 1946 were divided as follows:

[39] Harold G. Moulton, *Controlling Factors in Economic Development* (Washington, D.C.: The Brookings Institution, 1949), p. 204.

	Billions	*Per Cent*
Food and Nutrition	$ 55	37
Shelter and Home Maintenance	31	20
Attire and Personal Care	24	16
Education and Health	12½	8
Recreation and Travel	21½	14
Miscellaneous	7	5
Total	$151	100

Moulton states that, if the population of the United States were doubled and the plane of living were eight times as high, expenditures in the various categories would be multiplied as follows:

Food and nutrition—about eight times.
Shelter and home maintenance—about sixteen times.
Attire and personal care—about twenty times.
Health and education—about thirty times.
Recreation and travel—about thirty-three times.

A population of three hundred million people in the United States a century from now, and with living standards eight times as high as at present, would mean great pressure upon productive resources. Moulton poses the obvious question, "Would the natural endowment of the United States permit so vast an increase in production as would be involved?" [40] We will now turn our attention to the agricultural production potentials of the nation.

[40] *Ibid.*, p. 205.

CHAPTER 16

Irrigation Development in Relation to Natural and Man-Made Resources

The development of the United States has been characterized by westward expansion onto unsettled lands to provide the food and fiber for a growing population. Large areas of unoccupied public domain are no longer available in the continental United States. What opportunities do we have for further expansion of agricultural production as population growth and nutritional gains place heavier demands on the nation's food supply? This chapter is concerned with four means of increasing agricultural production. They are: (1) rehabilitation of eroded lands, (2) alternatives in land reclamation, (3) regional adjustments in agriculture, and (4) technology in agricultural production. Before considering these alternatives to irrigation development, however, the present status and potential extent of irrigated agriculture will be sketched briefly.

The total acreage under irrigation in the seventeen western states and Arkansas and Louisiana in 1948 was estimated to be approximately 22 million acres.[1] An estimate made by the National Resources Board in 1936 placed the ultimate irrigable area at 51,534,000 acres. The distribution of this estimate by states is shown in Table 8, as well as the acreages proposed for irrigation by the Bureau of Reclamation in 1948. The differences between the 1936 estimates of the National Resources Board and the current development plans of the Bureau of Reclamation reflect the growing emphasis upon irrigation possibilities on the eastern fringe of the semiarid region. For example, the acreage proposed for irrigation in South Dakota by the Bureau of Reclamation is almost six times the

[1] H. H. Wooten and Margaret R. Purcell, *Farm Land Development: Present and Future by Clearing, Drainage, and Irrigation,* U.S. Department of Agriculture Circular 825, October, 1949, p. 15.

TABLE 13

SUMMARY OF ESTIMATES OF POTENTIAL IRRIGATION DEVELOPMENT

Region and State	Area Irrigated [a]	NRB Estimate of Ultimate Irrigable Area [b]	Further Development Needed to Reach Ultimate	Further Development Under Way and Proposed by Bureau of Reclamation [c]		Percentage Which New Irrigation Proposals Are of Further Development Needed to Reach NRB Estimate	Extent Supplemental Water Project Proposals Cover Present Irrigated Area
				New Lands	Supplemental Water		
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Pct.*	*Pct.*
Pacific							
Washington	520,153	2,655,500	2,135,347	1,546,800	108,170	72.4	20.8
Oregon	1,129,059	3,512,900	2,383,841	1,065,580	211,700	44.7	18.8
California	4,952,819	16,673,000	11,720,181	1,763,500	2,110,000	15.0	42.6
Total	6,602,031	22,841,400	16,239,369	4,375,880	2,429,870	26.9	36.8
Mountain							
Idaho	2,026,280	3,755,500	1,729,220	792,390	978,430	45.8	48.3
Nevada	674,204	1,065,600	391,396	97,800	99,780	25.0	14.8
Arizona	736,027	1,578,800	842,773	254,535	607,660	30.2	82.6
Utah	1,124,081	2,164,900	1,040,819	158,647	271,725	15.2	24.2
Montana	1,555,480	3,865,600	2,310,120	1,037,160	342,900	44.9	22.0
Wyoming	1,353,873	4,060,600	2,706,727	838,100	332,710	31.0	24.6
Colorado	2,698,579	5,036,300	2,337,721	722,045	1,882,315	30.9	69.7
New Mexico	534,640	1,090,800	556,160	210,287	146,250	37.8	27.4
Total	10,703,164	22,618,100	11,914,936	4,110,964	4,661,770	34.5	43.6

Region and State	Area Irrigated [a]	NRB Estimate of Ultimate Irrigable Area [b]	Further Development Needed to Reach Ultimate	Further Development Under Way and Proposed by Bureau of Reclamation [c]		Percentage Which New Irrigation Proposals Are of Further Development Needed to Reach NRB Estimate	Extent Supplemental Water Project Proposals Cover Present Irrigated Area
				New Lands	Supplemental Water		
Plains	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Pct.*	*Pct.*
North Dakota	22,814	312,000	289,186	1,222,810	0	422.8	—
South Dakota	52,895	222,400	169,505	1,013,110	23,300	597.7	44.0
Nebraska	31,762	1,773,200	1,141,438	1,137,840	20,960	99.6	3.3
Kansas	96,248	1,333,000	1,236,752	237,020	830	19.2	.9
Oklahoma	2,237	127,400	125,163	231,592	600	185.0	26.8
Texas	1,320,216	2,307,400	987,184	881,200	624,300	89.3	47.3
Total	1,526,172	6,075,400	3,949,228	4,723,572	669,990	119.6	31.5
Total 17 States	18,831,367	51,534,900	32,103,533	13,210,416	7,761,630	41.1	39.9

[a] Census of Agriculture, 1945.
[b] *Land Available for Agriculture Through Reclamation*, National Resources Board, 1936.
[c] Data from Bureau of Reclamation as released through the National Reclamation Association, January, 1948.

Source: *Irrigation Agriculture in the West*, U.S. Department of Agriculture Miscellaneous Publication 670, November, 1948, p. 9.

further development estimated by the National Resources Board. In North Dakota, it is more than four times and in Oklahoma it is twice the further development needed to reach the ultimate acreage estimated by the National Resources Board.

What do the more than 13 million acres of new irrigated lands in the Bureau of Reclamation program mean in terms of production? The following statement of production changes expected on the 4,760,400 acres proposed for irrigation development and settlement in the Missouri River Basin is enlightening on that score:

> Although the production of corn would be nearly doubled on land proposed for irrigation, the expected increase would be only 3 per cent of the total present production in the Basin. For the United States, as a whole, it would be about one per cent. Production of alfalfa hay would be increased nearly 280 per cent on lands proposed for irrigation, about 50 per cent for the Basin, and 12 per cent for the United States. Sugar beets would show the most notable increase; this increase is estimated at 325 per cent of present production on lands proposed for irrigation. On the basis of 1944 production, the increase would be 290 per cent in the Basin and more than 100 per cent in the United States. Even on the basis of more recent years, the national production of sugar beets would probably be increased between 60 and 100 per cent as a result of the Missouri Basin Program. Potatoes and beans would each increase the national production by about 7 per cent. Wheat production would decline about 4 per cent in the Basin and 2 per cent in the country at large.[2]

With respect to production on irrigated lands throughout the reclamation states, the Census of Agriculture for 1949 showed that a large part is closely related to livestock enterprises. In that year more than 6 million irrigated acres were devoted to hay and about 4 million acres to irrigated pasture. These total more than half of the irrigated acres harvested and pastured in 1949. Grain was grown on more than 3 million acres. Much of this grain was used for livestock, but it amounted to only 5 per cent of the grain acreage of the seventeen western states and 9 per cent of the total grain production in these states. Fruits, vegetables, and other specialty crops accounted for more than 3 million acres of irrigated land.

[2] Sidney Henderson, "Changes in Crop Production Anticipated from Proposed Irrigation and Reservoir Development in the Missouri River Basin," U.S. Department of Agriculture, Bureau of Agricultural Economics (mimeo report), February, 1950, p. 18.

Sugar beets, potatoes, dry beans, rice, cotton, dry field peas, hops, grapes, and field seeds were other important crops on irrigated land.[3]

Resource development programs may remove land from production as well as adding to the available farm lands. In the case of the Missouri Basin, it has been pointed out that more than 1.5 million acres are included in the reservoirs proposed by the Army Engineers and somewhat less than 1 million acres in those of the Bureau of Reclamation.[4] Any consideration of how much new irrigated lands add to the agricultural plant of the nation should deduct such negative results of development.

Rehabilitation of Man-Abused Lands

Bennett has stated that the people of the United States have ruined more good land in less time than any other nation in recorded history.[5] There is by no means unanimity of opinion regarding the extent and permanence of the damage which has been inflicted on the lands of the United States. One view has been expressed as follows:

> . . . In any case the damage to the soil is very great, and the need for doing more to stop erosion is unquestionable. There is need, however, to question some of the interpretations of these data, in my opinion. . . . It is worth noting that the areas classified as "essentially destroyed" and on which erosion is "destructively active" total 1,057,000,000 acres which is about two and a half times the area of all the crop land in the United States and over half its total area. . . . Dr. Bennett states that it takes from 300 to 1,000 years to produce an inch of topsoil and that it can be lost in a single torrential rainstorm. . . . If we have to build up an inch of topsoil starting with solid granite rock it might take 1,000 years but in the case of the 100,000,000 acres of crop land which he claims have been irreparably damaged, how much of it is bare rock? I am sure you will find that a very high percentage of it is underlain with types of unconsolidated material which can be converted into soil in a much shorter period. . . . But the fact that yields which are more than double the average

[3] L. A. Reuss, H. H. Wooten, and F. J. Marschner, *Inventory of Major Land Uses in the United States*, U.S. Department of Agriculture Miscellaneous Publication 663, 1946, p. 53.

[4] Henderson, *op. cit.*, p. 31.

[5] H. H. Bennett, "The Development of Natural Resources: The Coming Technological Revolution on the Land," Address before the Engineering and Human Affairs Conference at Princeton University Bicentennial Conference, Princeton, N.J., October 2, 1946.

> yield of the United States were obtained within four years after the surface soil had been completely removed, all at one time, is evidence that some, at least, of these eroded soils are not gone forever.[6]

Objective determination of the amount of land which has been ruined for further use and of the degree of damage which places land beyond rehabilitation is not solely a question of physical status and relationships. Much of the land which has been abandoned or had its productivity greatly reduced through agricultural use can be restored—at a cost. The economic implications of the problem are clarified by the distinction made by Schickele between *soil deterioration* and *fertility depletion.* Soil deterioration implies impairment of the physical properties of the soil; i.e., a reduction in the value of productive capital. Fertility depletion is concerned with reduction in plant nutrients and organic matter through crop removals and leaching. Schickele pointed out, "Plant nutrients and organic matter can be restored to the soil through commercial fertilizers and manure, and excessive soil acidity can be corrected by liming. Whether it is economically profitable to do this, of course, depends entirely on the relative price of inputs and farm products." [7] With respect to the more serious problem of soil deterioration, Schickele wrote: "Erosion is the most conspicuous form of soil deterioration and, from an economic viewpoint, also the most dangerous because of its irreversible character. Once the fertile top soil is washed away and the land is dissected by numerous gullies, it is extremely difficult and often impossible to restore a profitable level of productiveness." [8]

The rehabilitation of eroded and depleted lands can be the basis for substantial increases in agricultural production. As growing demands for food places greater pressure on land resources, the acreage is likely to be extended on which the more costly phases of rehabilitation can be economically justified by the individual farm operator. The extent to which government finds it in the public

[6] Richard Bradfield, "Soil Productivity and the Potential Food Supply of the United States," Address before the Academy of Political Science, Columbia University, November 10, 1948.

[7] Rainer Schickele, *Economics of Agricultural Land Use Adjustments*: I, *Methodology in Soil Conservation and Agricultural Adjustment Research*, Iowa Agricultural Experiment Station Research Bulletin 209, March, 1937, p. 363.

[8] *Ibid.*, p. 363.

interest to subsidize such activities through benefit payments and technical assistance will also be a major factor in determining how important the rehabilitation of eroded and depleted lands may be in filling demands for expanded agricultural production.

Another situation where there is considerable opportunity for rehabilitation of agricultural lands is concerned with irrigation agriculture itself and, strangely enough, is a by-product of man's efforts to improve resources. Black has stated: "The three major lines of development in irrigation are salvaging and better management of lands already under irrigation, supplying more water to land now inadequately supplied, and bringing new land under irrigation. The first of these may be as important as the other two." [9] The salvaging of lands now under irrigation involves, in almost every case, the providing of adequate drainage.

Many irrigation developments, including publicly built projects, failed to include facilities for the disposal of excess irrigation waters. The result has been that large areas of irrigated land have been abandoned or their productivity has been greatly reduced because there were no drainage ditches to carry away the water not absorbed. The use of increased water supplies, seepage of ground water from higher land, and low permeability of soils in lower areas have been listed as the causes of waterlogging.[10] Drainage systems have been installed on many irrigation projects after it became obvious that the natural drainage was not adequate. The cost of building a drainage system after the irrigation system has been completed is, of course, much greater than if it had been included in the original design and construction of the irrigation project. All irrigation projects now being planned or constructed by the federal government include necessary drainage facilities in the original engineering design.

Viewed as a whole, then, the lands lost to agriculture through whatever cause, the lands yet to be lost, and the lands which can be rehabilitated are all a part of any consideration of the size and production potential of the nation's farm plant.

[9] By permission from *Farm Management*, by John D. Black, Marion Clawson, Charles R. Sayre, and Walter W. Wilcox, p. 867. Copyright, 1947, The Macmillan Co., New York.

[10] J. Howard Maughan, Orson W. Israelsen, and Eldon G. Hanson, *Drainage Districts in Utah, Their Activities and Needs*, Utah Agricultural Experiment Station Bulletin 333, January, 1949, p. 11.

Alternatives in New Land Reclamation

It was noted in Chapter 1 that land reclamation includes more than irrigation development. It includes any process of irrigation, drainage, clearing, diking, or filling in of land which makes it usable for agriculture. There is, therefore, from the standpoint of the national interest, a question of alternatives in lands to be reclaimed. Is it more economical to irrigate arid lands, drain swamplands, or clear timberlands?

Land policies of the federal government have included the encouragement of swampland reclamation for more than a century. The Swamp Land Act was passed in 1849. This Act granted to Louisiana all swamps or overflowed lands unfit for cultivation and the policy was made general in an act passed in 1850. Proceeds from the lands ceded to the states were to be applied to the purpose of reclaiming these lands by means of levees and drains. Since the Civil War, the selection of swamplands has declined until today only a few acres are patented annually. The Swamp Land Act was subject to the same kind of misuse which was associated with other legislation disposing of the public domain. It was found on examination that three-fourths of the land claimed was not swampy or subject to serious overflow.[11] Renne states, "More than 75 million acres in 38 states of the United States are provided with drainage sufficient for normal crops. Nearly 5 million additional acres are partly drained. A total of 87 million acres is included in nearly 40,000 organized drainage enterprises, of which 7 million acres are unfit to raise any crop because of lack of drainage." [12]

Drainage work is commonly carried out through *drainage districts*, which are organized in the various states under enabling acts similar to those which authorize irrigation districts. The bulk of the organized drainage enterprises are located in the midwestern states, in the South, and in the irrigated areas of the West. Intensive studies of the economic implications of drainage reclamation are being made in the lower valley of the Mississippi River.[13] The fed-

[11] R. R. Renne, *Land Economics* (New York: Harper & Bros., 1947, p. 369.
[12] *Ibid.*, p. 368.
[13] Robert W. Harrison and Walter Kollmorgen, "Land Reclamation in Arkansas Under the Swamp Land Grant of 1850," *Arkansas Historical Quarterly*, Winter, 1947, pp. 369–418; Robert W. Harrison and Walter Kollmorgen, "Past and Prospective Drainage Reclamations in the Coastal Marshlands of the Mississippi River

eral government has never instituted a program of drainage reclamation similar to federal irrigation development, although many persons have stressed the desirability of such an undertaking. In recent years, both the Soil Conservation Service and the Army Engineers have broadened the scope of their work with respect to drainage. Among the states, the experience of the Louisiana Department of Public Works is of interest to other states.[14]

Harrison has emphasized the multiple-use character of water problems in the Lower Mississippi Valley by pointing out that efforts to improve navigation and control floods are closely related to problems of land development and land settlement. Harrison wrote:

> . . . flood control, drainage, and clearing are three basic steps in land development in the Mississippi Valley. Work in these three fields has advanced simultaneously, but not necessarily uniformly. Sometimes drainage works have advanced more rapidly than the status of flood control warranted, with consequent loss of capital investments. Often clearing for agriculture has got ahead of drainage, resulting in much suffering and economic loss to the new-ground farmer and his family.[15]

It has been estimated that there are about 91 million acres of land which could be improved for agricultural purposes or reclaimed by drainage.[16] Most of these lands are located in the southeastern states, in the Mississippi River Delta, and in the Pacific Northwest.[17]

Land clearing may be carried on in connection with drainage or it may be a form of land reclamation where drainage is unnecessary. The original forested area of the United States has been estimated at 820 million acres. This figure does not include 84 million acres

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Delta," *Journal of Land and Public Utility Economics,* XXIII, No. 3 (August, 1947), 297–320; Robert W. Harrison and Walter Kollmorgen, "Drainage Reclamation in the Coastal Marshlands of the Mississippi River Delta," *The Louisiana Historical Quarterly,* XXX, No. 2 (April, 1947), 1–57.

[14] Robert W. Harrison, "Louisiana's State-Sponsored Drainage Program," *The Southern Economic Journal,* XIV, No. 4 (April, 1948), 387–403.

[15] Robert W. Harrison, "Land Economic Research in the Alluvial Valley of the Lower Mississippi River," *Journal of Farm Economics,* XXIX, No. 3 (August, 1947), 593–615.

[16] National Resources Board, *Land Available for Agriculture Through Reclamation,* Part IV of the Report on Land Planning (Washington, D.C.: Government Printing Office, 1936), p. 39.

[17] Wooten and Purcell, *op. cit.*

of arid woodland. Total land cleared from forest now in use for farming and other nonforest purposes is estimated at 375 million acres.[18]

The land clearing operation has been facilitated by mechanization in recent years. An Arkansas study noted, "The development and adaptation of specialized machinery for cutting and piling trees have been important factors in the accelerated expansion of land clearing in this area." [19] The study concludes, "Thousands of acres of bottom land in northeast Arkansas have been cleared in the last three or four years. This has meant the development of many new farms and the enlargement of hundreds of established farms." [20] Harrison has characterized the Delta of the Mississippi as one of the nation's last land frontiers and suggests that the synthesis of modern technology and social objectives will make for unprecedented expansion of the area.[21]

The Lower Mississippi Valley and Coastal Plains of the South have been listed as an important source of new farm lands during the next several years. The Northeast and the Lakes states will see continued clearing of new lands but largely as additions to the cropland of existing farm units rather than as new farms. It has been noted that, in most areas, the new lands will not provide new farm opportunities for many people from the outside. There are enough local youth to utilize all available lands.[22]

The position of the various forms of new land reclamation in competing as sources of new agricultural production depends upon the costs of the particular kinds of reclamation and the returns to be realized from the developed lands. Associated multiple-purpose values and extramarket values will also be factors in choosing among alternatives for public action. With respect to various forms of land development, Wooten and Purcell have presented some representative cost figures. Costs of land clearing with heavy equipment in Connecticut ranged from $50 to $100 per acre.[23] Contract rates

[18] *Ibid.*

[19] George F. Jenks and Robert W. Harrison, *Methods and Cost of Clearing Land in Northeast Arkansas,* Arkansas Agricultural Experiment Station Bulletin 495, June, 1950, p. 15.

[20] *Ibid.*, p. 41.

[21] Robert W. Harrison, "Research in Land Development in the Alluvial Valley of the Lower Mississippi River," *Journal of Farm Economics,* XXXIV, No. 1 (February, 1952), 1–13.

[22] Wooten and Purcell, *op. cit.*

[23] *Ibid.*, p. 22.

for land clearing in the North Carolina and South Carolina coastal plain ranged from $36 to $50 per acre in 1947. Fairly complete land improvement, clearing, stumping, and farm drainage, with farm labor, cost $60 to $75 or more per acre.[24] In the Delta area of the Mississippi Valley, new open drainage has run from $8 to $25 or more per acre, depending on the difficulty of the job. Average rates for clearing ranged from $30 to $60 and even up to $100 or more per acre, depending on the work to be done and the completeness of the job.[25] In the Pacific Northwest, 1940 costs for clearing (using the bulldozer) averaged $18 per acre for very easy jobs, $39 for easy jobs, $57 for medium jobs, and $80 per acre for difficult jobs. Others ran as high as $200 per acre for clearing heavy timber and large stumps.[26] These costs for clearing and drainage can be compared with costs for western irrigation development quoted by Wooten and Purcell. Major construction charges allocated to settlers in some areas amount to $75 and even more than $100 per acre. Costs per acre of leveling, clearing, and ditching in preparation for irrigation frequently will be $50 to $100 or more in addition to the original costs of land and irrigation construction.[27]

Regional Adjustments in Agriculture

Changes now under way or in prospect in some major agricultural regions may be of considerable importance in future agricultural production. The adjustments being made in the agriculture of the South are undoubtedly the most significant on a regional basis. Agricultural diversification and farm enlargement were promoted by the shifts which accompanied World War II. The industrialization of the South, which was accelerated by World War II, has continued since the end of the war. The availability of employment opportunities in industry have made it possible for some of the people on the land to leave agriculture. Population pressure on the land in the South has meant low productivity per worker, low farm incomes, and a low standard of living. Industry has provided an outlet for the underemployed in southern agriculture and is making possible highly desirable adjustments in the region.

[24] *Ibid.*, pp. 27–28.
[25] *Ibid.*, p. 35.
[26] *Ibid.*, p. 41.
[27] *Ibid.*, p. 56.

As recently as a decade ago, many southerners were pessimistic regarding the possibilities of making adjustments in the agriculture of the South. Others were optimistic as to what might be accomplished with the human and natural resources of that region. It appears that the most difficult problem to overcome may have been the third one listed by Harrison in 1944. He placed the problems in the Southeast in three major categories: (1) those of economic organization and operation of agricultural resources; (2) those of developing harmonious relationships among agriculture, labor, and commerce; and (3) those of reorienting social and economic outlook and philosophy as they affect agriculture.[28] Calkins wrote in 1950, "When one considers what has been done in the region, and sees the current evidences of progress, he is aware that a new spirit is abroad in the South."[29] Going on to note that the progress to date is encouraging but not great enough and that more deliberate effort is necessary, this writer observed:

> It is an astonishing fact that we know comparatively little about the techniques by which the over-all development of a region can be encouraged. This is a singular situation in view of the voluminous verbiage on economic and social improvement; and it is the more astonishing in light of the fact that in three hundred forty-three years of English settlement of this continent we have been preoccupied with just this enterprise and have been more successful at it than any other people in the history of the world. From the first adventures in settlement down to the last investment for the future, we have been promoting a better life for our people. We have learned a lot about it in specialized fields, and yet we know very little about it in any formal and over-all sense.[30]

Black noted the need for concrete measures to encourage adjustments in the South when he wrote:

> The South will see the largest readjustments of any major part of the country. Over large sections of the South, cotton will decline to the position of an important supplementary cash crop. The core of the farming systems in these parts of the region will be the growing of forage, corn, and winter small grains and feeding these, first, to dairy cattle, second, to beef cattle, and third, to swine. The farms

[28] Robert W. Harrison, "A Philosophy of Agriculture Adjustment with Particular Reference to the Southeast," *Journal of Farm Economics,* XXVI, No. 3 (August, 1944), 448–60.

[29] Robert D. Calkins, "Strategic Approaches to Southern Progress," *Journal of Farm Economics,* XXXII, No. 4, Part II (November, 1950), 697–708.

[30] *Ibid.*

over large areas will go under intensive grassland management. Needless to state, accompanying these changes will be a large absorption of small farms into neighboring farms to make economic units. . . . which will make as full use as they can of modern power equipment. The prospective changes in this direction are so great that they will not be completed in less than half a century *unless private and public credit and farm planning services are provided in large measure.*[31]

The progress of the past decade toward improvement of agriculture in the South has been notable. The greater diversity and the higher levels of agricultural production have significant implications in any consideration of national population-food problems. It may be that the increase in the production of fruits and vegetables, meat products, and dairy products will no more than fill the needs of a larger population and a higher level of nutrition in the region. This, in itself, would be a major contribution to the nation as a whole.

Adjustments in another major agricultural region, the Corn Belt, are likely to be in the direction of maintaining and expanding the productivity of an established pattern of agriculture. Probable changes have been described as:

. . . a general moderate intensification of farming, achieved by use of more machinery, power, and fertilizer, rather than by the use of more labor. Still more of the smaller farms will be absorbed into fully mechanized family farms. Cultivated crops will tend to be concentrated in the more nearly level lands, and the sloping lands will go into longer rotations and under more intensive grassland management.[32]

A study of the Corn Belt states and Lake states pointed out that there should be a shift of 24.6 million acres of permanent pasture and idle land into crops and a shift of 24.5 million acres of unsuited land out of cropland use.[33] It was noted:

It seems desirable that the Nation know the production potential of its agricultural resources, with a conservational system of land use, both for the Nation as a whole and for the several important regions. By knowing what can be produced in physical terms, the Nation would know the extent to which it can increase the production of food and fiber from its own resources to meet the needs of an increase in

[31] John D. Black, "Coming Readjustments in Agriculture—Domestic Phases," *Journal of Farm Economics*, XXXI, No. 1, Part I (February, 1949), 1–15. (Italics are mine.)

[32] *Ibid.*

[33] George H. Walter, *Possible Effects of Conservational Land Use on Production in the Corn Belt States and Lake States*, U.S. Department of Agriculture, Bureau of Agricultural Economics, Washington, D.C., December, 1947, p. 1.

> population. It would know the extent to which it can be self-sufficient in times of national emergency of some duration. It would know to what extent it can contribute food and fiber to deficit areas of the world without destruction of its soil resources.[34]

Technology in Agricultural Production

The question arises as to how much of the increased food requirements resulting from a larger population and the loss of agricultural lands through erosion will be offset by advancing technology in agriculture. The effects of better farming methods, more productive animals, more productive hybrids and varieties of seeds, more spraying and dusting of crops, and more use of fertilizers are all of great importance in any determination of land requirements. In the opinion of the writer, agricultural technology is an effective answer to much of the alarmist writing of the Neo-Malthusians.

It has been pointed out that American agriculture has grown in two main ways: "The first was primarily settlement—the expansion of farmers into new areas of a wild continent. The second is technological advance—the creation of more fruitful ways of making the means of life." [35] The release of acreage which formerly produced feed for horses and mules to the production of food for humans has been a part of technological development. From 1910 to 1940, the horse and mule population declined over eleven million on farms and some three million in the cities, thus releasing some fifty million acres as a human food and fiber resource.[36] The more important implications of technology for the long run are stressed in the following:

> . . . the outracing of population growth by output for human use per farm worker has almost ceased to be the result of a temporary shift in the form of farm power and has become the function of more permanent characteristics of scientific agriculture, such as better plants and animals, disease and pest control, wider use of fertilizer, soil care, and so on. From 1920 to 1930, the substitution of machine for animal power was responsible for one-half of the increase of farm output for human use, one-third during the next decade, and only one-

[34] *Ibid.*, p. 49.

[35] John C. Ellickson and John M. Brewster, "Technological Advance and the Structure of American Agriculture," *Journal of Farm Economics*, XXIX, No. 4, Part I (November, 1947), 827–47.

[36] A. P. Brodell, "Tractors Don't Eat Oats," *Land Policy Review*, IV, No. 8 (August, 1941), 25–28.

tenth from 1940 to 1945. In 1920 horses and mules used up 21 per cent of total farm production, but only 7 per cent by 1945. Should this rate continue, the conversion of farm production for workstock to food and fiber for human use would be substanitally completed about 1955.

In short, although the substitution of mechanical power is still of some importance in increasing per worker output for human use, the outracing of population growth by farm technological advances as reflected in such output now comes chiefly from other sources. There is, therefore no tangible reason why agriculture should not continue for the visible future as an expanding industry in terms of food and fiber output but a contracting industry in terms of the number of farms and farm workers required to feed and clothe the Nation.[37]

With respect to the needs for land resources, the importance of advancing agricultural technology is reflected in the trends in farm production per acre. The effect of technology on crop production per acre and production per animal unit is shown in Figure 5. It will

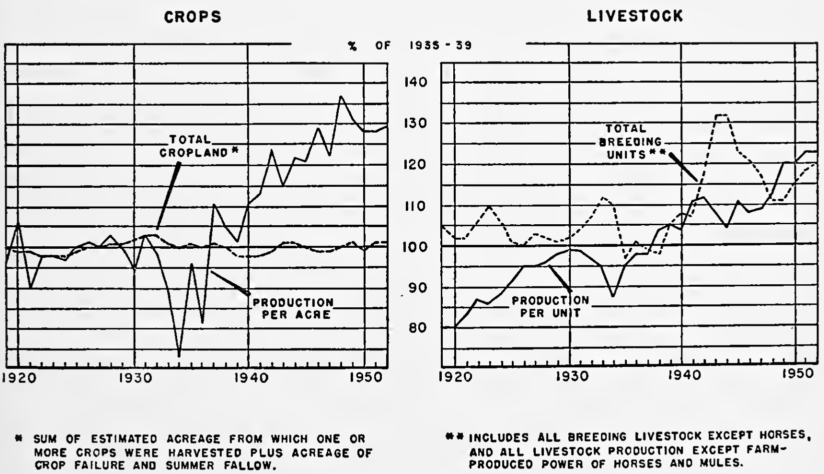

FIGURE 5. Farm Production per Acre and per Animal Unit, 1919–52. (U.S. Department of Agriculture, Bureau of Agricultural Economics, Agricultural Outlook Charts, 1953.)

be noted that crop production per acre had increased until, in 1951, it was almost 140 per cent of the 1935–39 level, while livestock production per animal unit in 1951 was 116 per cent of the 1935–39 level. As late as 1943, Pearson and Paarlberg had written, "Among the many factors that affect crops, not one points to materially

[37] Ellickson and Brewster, *op. cit.*

higher production."[38] At that time, crop production was already 115 per cent of the 1935–39 level and increased another 25 per cent in the next eight years. As an average for the years of World War II, crop production per acre was about 20 per cent higher and livestock production per animal unit of breeding stock was nearly 10 per cent higher than before the war.[39] It should be remembered that some of the components of advanced agricultural technology were in limited supply during this period. The wide adoption of hybrid corn was the most important single factor in the rapid increase in crop production per acre.

The increase in livestock production per animal unit is, in effect, a multiplication of the increased crop yields per acre, i.e., more livestock was fed on the production from the acres on which the per acre production has increased.

Despite the substantial increases in crop production per acre and livestock production per animal unit, Schultz has argued that American agriculture as a whole is inefficient. Among the major agricultural regions the West is the most efficient, having an output per man equivalent two and a half times as large as that of the South. At the same time, in the West in 1939 manufacture added two and a half times as much per worker as did agriculture. The significant point to this argument is that many workers in agriculture are on small farms with limited resources. Less than one-tenth of the farms in the United States are in the more efficient region of the West; one-half of them are in the South.[40] There are, of course, two possible lines of action in connection with the lack of production efficiency on small farms: (1) reduce the number of small farms or (2) find means of extending the techniques of efficient agriculture to the small farms. In considering possibilities for expanded agricultural production during World War II, Schickele viewed small farms as a major source of increased production if they were given access to the means of efficient operation.[41]

[38] Frank A. Pearson and Don Paarlberg, *Food* (New York: Alfred A. Knopf, Inc., 1944), p. 68.

[39] Raymond P. Christensen, *Efficient Use of Food Resources in the United States*, U.S. Department of Agriculture Technical Bulletin 963, October, 1948, p. 18.

[40] Theodore W. Schultz, *Production and Welfare of Agriculture* (New York: The Macmillan Co., 1949), pp. 49–63.

[41] Rainer Schickele, "Obstacles to Agricultural Production Expansion," *Journal of Farm Economics*, XXIV, No. 2 (May, 1942), 447–62.

The application of agricultural technology increases the land supply available for society's food and fiber requirements without adding to the total number of acres available to farmers. A report of the Tennessee Valley Authority states the situation as follows:

> . . . it means that, despite profligate use of natural resources, the striding advances of science and technology make poverty and hunger out of the question. Our experience in World War II has confirmed this conviction. A nation that fought a victorious war, armed and fed its allies, and at the same time raised the income and consumption of its civilian population to an all-time high—such a nation need not lapse into the bewildered economic and social paralysis that characterized the depression of the thirties.[42]

[42] Tennessee Valley Authority, *Food at the Grass Roots*, Knoxville, Tenn., 1947, p. 5.

CHAPTER 17

Irrigation Development in Relation to Long-Term National and Foreign Policy

It would appear that the nation's population-food problem would easily be solved by a balancing of all factors affecting the demand for food and fiber against all the factors associated with agricultural production. In actual practice, the problem is not so simple. The United States has never had a resource policy related to the needs of the nation at any particular time or in the long run. Rather, public action with respect to land and water resources has followed a devious course through the years. The factors accounting for this lack of direction are many and varied, including such things as prejudice, political expediency, emotional appeal, lack of information, the issues of the times, the mood of Mother Nature, or the philosophy of individual leaders. Public policy with respect to irrigation development has been influenced to a greater extent by such factors than it has by objective consideration of resource needs.

Irrigation and Farming Opportunities

The United States began its history as an agricultural nation with great land resources. Anyone who wanted to become a farmer could do so, and it quickly became a basic part of national policy for the government to give help in various ways in order to encourage settlement of the vacant lands. The idea that the government should provide farming opportunities for everyone wanting to farm became fixed in the American mind and continues to recur even in a society with less than 20 per cent of the population living on farms. It will be remembered that the original entry of the federal government into the field of irrigation development was to broaden the opportunities for people to become established in agriculture.

One group has come in for special attention in the providing of farming opportunities. Throughout the years, the federal government and many of the state governments have taken steps to make lands available to war veterans. The practice of making land grants to war veterans, either directly or through issuance of scrip, began with the Revolutionary War. Following more recent wars, the public domain had been disposed of to the extent that the general practice of granting lands was impossible. Bonus payments and educational privileges may be considered to have been in the nature of substitutes for land grants to war veterans. Some lands were made available, however, following both World War I and World War II. The lands available for homesteading by veterans following World War I were largely of poor quality and many of the veterans who settled on them were unable to become established on a sound basis.

The tradition of providing farming opportunities for returning war veterans persisted even following World War II.[1] The possibilities were limited, however, being confined to lands which might be brought into agricultural use through irrigation, drainage, and clearing and the return to agriculture of lands which had been taken for military use. War veterans have been given preference on such lands as have become available and the recipients were determined by lottery. Land hunger and the desire to farm continue strong among the American people. The Bureau of Reclamation stated that inquiries regarding farming opportunities were running as high as one hundred per day one year after the end of World War II.[2] In a drawing at Riverton, Wyoming, in August of 1950, 11,367 World War II veterans competed for a chance at fifty-four new farms opened to homesteading.[3]

Although the Bureau of Reclamation used the providing of farming opportunities for veterans as an argument in support of further irrigation development at the end of World War II, it is obvious that the time is gone when the government can offer such opportunities in any sizable number. It is doubtful if the new farms on irrigated lands will provide any net gain in farming opportunities over and above the future decrease in the number of farms resulting

[1] Hugh H. Wooten, "Farming Opportunities for Veterans," *The Journal of Land and Public Utility Economics*, XXI, No. 3 (August, 1945), 259–67.

[2] Associated Press release, Washington, D.C., August 10, 1946.

[3] *Great Falls Tribune* (Montana), August 16, 1950.

from continued gains in technology. The idea of abundant farming opportunities dies hard, however, in a nation which appeared to have an almost limitless frontier as recently as a half-century ago.

Irrigation in the Western Economy

Irrigation development has been supported by Congress because of a recognition of its importance to the western states. At the same time, there has been widespread doubt as to whether or not such public action is of value to the nation as a whole. The significance of irrigated agriculture in the western economy is illustrated by the following:

> Of the $1,356,098,000 cash farm income produced in the eleven western states, forty-nine per cent came wholly from irrigation. An additional thirteen per cent was produced partly from irrigated, partly from non-irrigated land. The portion attributable to irrigation was thirty-five per cent, or five per cent of the total. On the assumptions used herein, fifty-four per cent of the total cash farm income of these eleven western states is attributable to irrigation and forty-six per cent to humid land, dry land, and range land.[4]

Some people contend that the position of irrigation would be strengthened if it were considered as a national problem rather than one of sectional interest only. Others feel that the case for irrigation must be argued solely on the basis of its importance to the western states. One viewpoint is expressed in these words: "It is unfortunate that reclamation by irrigation has come to be thought of as having a status apart from the general welfare of the whole country. To be sure, it has rights attaching particularly to the western region, but nevertheless its uses are inseparably intertwined with broad national considerations." [5]

In discussing the consideration of irrigation as a problem of national import, Johnson wrote: "From a national standpoint irrigation proposals should be evaluated on the basis of whether they will contribute more or less to national welfare than other public works proposals involving equal expenditures. To arrive at a fair decision

[4] Marion Clawson, "Post-War Irrigation Developments and the National and Regional Agricultural Economy," *Journal of Farm Economics,* XXVII, No. 1 (February, 1945), 138–52.

[5] John W. Haw, "Irrigation and the Land-Use Program," *Civil Engineering,* VI, No. 10 (October, 1936), 663–67.

on this question is admittedly difficult and public works projects are not often approved on such a basis. . . ." [6] A further statement by this writer takes us back to the significance of irrigation to western agriculture. He said: "The most valid arguments for including irrigation development in a national program of public works are based upon the need for irrigated land to utilize more fully and more safely the other natural resources of the region. . . ." [7]

The peculiar position of irrigated agriculture in the western economy is well stated by Whitaker and Ackerman in the following excerpt:

> One may travel for miles across sagebrush country, then come suddenly to green fields and clean, thrifty-looking towns. These two contrasting types of land, dry range and irrigated field, not only occur in proximity, but also are intimately related in use. The fruit and vegetables grown on irrigated lands are perhaps better known, but forage crops grown on irrigated lands are more important in acreage and in the economy of the surrounding areas. Irrigated land is most used to produce feed for livestock, which spend part of the year on the adjacent range, both lowland and mountain. Looked at from a national point of view, irrigation is valuable primarily because it makes possible profitable use of the immensely larger areas that must be used without irrigation. From a local and regional point of view, irrigation is the life support of the people. . . ." [8]

In addition to its close integration with the production of livestock, irrigated agriculture has a dual role in crop production for human consumption: (1) to fill the food requirements of people living in the area, and (2) provide specialty crops which cannot be grown in certain seasons in the eastern United States.[9] Many irrigated areas of the West are particularly adapted to the production of specialty crops.

A former Chief of the Bureau of Agricultural Economics asked whether new lands should be developed on the basis of promotion, sectional pride and desire, or the assurance of profitable operation. In reply, he wrote:

[6] Sherman E. Johnson, "Irrigation Policies and Programs in the Northern Great Plains Region," *Journal of Farm Economics*, XVIII, No. 3 (August, 1936), 543–55.

[7] *Ibid.*

[8] J. Russell Whitaker and Edward A. Ackerman, *American Resources—Their Management and Conservation* (New York: Harcourt, Brace & Co., Inc., 1951), p. 156.

[9] John W. Haw, "Economic Problems of Western Reclamation," *Agricultural Engineering*, XII, No. 4 (April, 1931), 123–28.

> It is not a question of developing the agricultural resources of one region as against those of another. It is not a question of North versus South, and East versus West. It is not a question of more irrigation or less irrigation, for no reasonable person would question that the waters of irrigation ditches are as vital to the agricultural life of the West as generous rainfall is to the farming life of the East. But it is a question of developing the agricultural resources of the East and the West, of the humid and the semiarid regions, of the drainage and irrigation sections, in keeping with the probable demand for the products of such lands, the economic soundness of such developments, and the probability of returns that will enable such lands to rest on their own bottoms.[10]

Industrial Development of the West

The over-all economic framework within which western irrigation functions has undergone significant change in the past decade. The population growth of the western states was noted in an earlier chapter. The broadening of the economic base through industrial development is a major factor in the new West. The extent of the industrial growth in the fifteen western states has been stated by Berge thus: "From the beginning of the national emergency through April 1945, the West filled contracts for war supplies valued at twenty-nine billions of dollars—an amount five times more than the value of all manufactured products from the area in 1939." [11] In the Pacific Northwest, the availability of large quantities of low-cost hydroelectric power is credited with having been a major factor in the region's industrial expansion from 1939 to 1947. It has been noted also that the lack of sufficient power will retard postwar industrial growth until about 1955.[12]

Industrial development in the immediate region of irrigated agriculture has caused significant changes in the types of agricultural production for which markets are available in the region as well as increasing the volume of production required. The effect of the

[10] Nils A. Olsen, "The Agricultural Outlook and the Land Problem," *Proceedings of the National Conference on Land Utilization*, Chicago, Ill., November 19–21, 1931, pp. 3–17.

[11] Wendell Berge, *Economic Freedom for the West* (Lincoln, Nebr.: University of Nebraska Press, 1946), p. 8.

[12] V. B. Stanbery, "Growth and Trends of Manufacturing in the Pacific Northwest, 1939–47," Report submitted to the Columbia Basin Inter-Agency Committee, Portland, Ore., June 28, 1950.

industrial development of the West on the agriculture of an irrigation state has been described as follows:

> . . . there has been but little increase in the agriculture of Utah during the past 25 years. However, especially since 1940, there has been considerable increase in trade and other types of economic activities, and in local demand for agricultural products. . . . The necessities of war were responsible for the industrial development of Utah. . . . The growth of the California market is a powerful factor in the industrialization of Utah as much of Utah's produce must find outlets there . . . there has been difficulty in providing certain products.[13]

The economic development of the West has been hampered by two major factors: (1) the isolation of the region from the populous consuming centers, and (2) certain institutionalized features including discriminatory freight rates and the entrenched industrial interests of the East. The large population growth of the West is bringing new markets to the region and eliminating some of the handicap of distance. Many of the man-made barriers to the development of the West are the most difficult to overcome. Slow but steady progress is being made, however, and the western states can look forward to a greater degree of economic equality with the East.[14]

Some of the obstacles to industrial development of the West might stand for years if it were not for programs of public resource development throughout the western states. Such public activity has tended to offset some of the basic factors of location which would ordinarily indicate continuance of a raw materials economy for much of the region.[15] It has been said that the government plans to develop a great industrial-agricultural empire in the West centered around water-resource projects. Expenditures are expected to total thirty-seven billion dollars and result in a population increase of fourteen million persons in the western states by 1975.[16] Such a program has great significance for irrigation agriculture in the West.

[13] W. P. Thomas *et al.*, *The Colorado River and Utah's Agriculture*, Special Report 1, Utah Agricultural Experiment Station, April, 1949.

[14] A. G. Mezerik, *The Revolt of the South and West* (New York: Duell, Sloan & Pearce, Inc., 1946).

[15] Edgar M. Hoover, *The Location of Economic Activity* (New York: McGraw-Hill Book Co., Inc., 1948).

[16] "37 Billions to Remake the West," *U.S. News and World Report*, December 2, 1949.

Irrigation and the Business Cycle

A government which adopts a policy of expending public funds to offset depressed economic conditions has two primary methods available for doing so. They are (1) direct relief payments and (2) a program of public works. Public irrigation development is a vital part of any effort to relate government programs of public works to the business cycle. Public works have been defined as durable goods, primarily fixed structures, produced by the government.[17] Arguments against public works have been listed as follows by Bowman and Bach: [18]

1. Public works projects are slow to get started.
2. Public works projects are likely to keep high exactly those sticky costs that ought to come down if real recovery is to be achieved.
3. Public works may be in direct competition with private industry.

The same writers listed the following arguments in favor of public works: [19]

1. A dole is likely to be destructive to the morale of the unemployed workers.
2. Public works are a more direct stimulus to the durable goods industry than are relief payments.
3. Public works give us something to show for our money.

Public expenditures may emphasize one of three major attacks on the depression phase of the business cycle. They are (1) pump-priming, (2) compensatory spending, and (3) secular spending. The theory underlying pump-priming is that the economic system is temporarily jammed. It is contended that the spending of a large sum of borrowed public money will get the normal flow of income started and then private enterprise will resume its usual investment and spending activities.[20] Compensatory spending is

[17] John Maurice Clark, *Economics of Planning Public Works*, National Planning Board of the Federal Emergency Administration of Public Works (Washington, D.C.: Government Printing Office, 1935), p. 2.

[18] Mary Jean Bowman and George Leland Bach, *Economic Analysis and Public Policy* (New York: Prentice-Hall Inc., 1943), p. 694.

[19] *Ibid.*, p. 695.

[20] Arthur E. Burns and Donald S. Watson, *Government Spending and Economic Expansion*, American Council on Public Affairs, Washington, D.C. (2d ed., 1941), p. 45.

fundamentally an attempt to stabilize the economy by counteracting excessive fluctuations in private spending by opposite fluctuations in public spending.[21] The concept of secular spending questions the availability of adequate investment opportunities for private enterprise and holds that public investment is necessary on a long-run basis.[22] At the moment, we are concerned with the compensatory aspects of public irrigation development.

Construction of a major water resources project may have either inflationary or deflationary effects upon private enterprise. During periods of full employment of resources, public construction reduces over-all output and thus has an inflationary effect. During periods of less than full employment, public construction may create a desirable immediate demand for labor, durable goods, and farm products. If the business cycle continues to decline over a long period of time, the completed project may further deflate the market by adding to the output of commodities. It is apparent that some importance attaches to timing the development of water resources.

Timing of a public works program involves certain difficulties which hinder the quick expansion of construction during a business recession. Clark noted:

> . . . obstacles to quick expansion are well known, including the legislative procedure of appropriation-making, or authorizing borrowing and carrying it out, of selecting sites and acquiring land, of drafting and examining plans, receiving bids and letting contracts. Furthermore, on projects of considerable size, it frequently requires at least a considerable part of a year before the preliminary stages of the work are out of the way and a stage is reached where a large volume of employment can begin.[23]

The possibility of expanding irrigation development as part of a depression-oriented public works program is further complicated by opposition to agricultural expansion at such times.[24] The depression phase of the business cycle ordinarily finds agriculture relatively worse off than other segments of the economy. Peck wrote:

> Those who favor the reclamation of additional land for agricultural use contend that the additional quantities of agricultural products

[21] *Ibid.*, p. 57. [22] *Ibid.*, p. 71. [23] Clark, *op. cit.*, p. 63.

[24] Frank P. Willits, "The Futility of Further Development of Irrigation Projects," *Annals of the American Academy of Political and Social Science*, CXLII (March, 1929), 186–95.

brought forth would be so small they *would not* have an appreciable effect on prices. Those opposed to further reclamation hold that, on account of the inelasticity of demand for most of the staple agricultural products, an increase in production *would* affect prices appreciably.[25]

In support of the latter point of view, Peck presented the following comparisons for the 1927 crop year:

1. The gross income obtained from potatoes on federal irrigation projects amounted to $10,226,710. Because of the inelasticity of the demand for potatoes, the production of potatoes on irrigation projects depressed the price to such an extent that potato growers lost $15,664,220 over what they would have grossed without production on irrigation projects.
2. Cotton grown on federal irrigation projects had a gross value of $16,705,727. The price was depressed so that nonproject growers lost $40,000,000.
3. The gross value of wheat on federal projects was $15,196,000, which was almost exactly the same as the loss to nonproject producers as a result of the lower price resulting from the irrigated production.
4. Corn production on federal irrigation projects was too small to affect the price.

In view of such opposition to further irrigation development in 1929, it is not surprising that there was no indication of any planned program to include such public works in the antidepression policies which were inaugurated during the 1930's. Increased activities relating to the conservation and control of water have been attributed to the following circumstances:[26]

1. Nationwide abnormality of climatic and hydrologic conditions during the 1930–40 decade.
2. Economic crisis and depression brought changes in political leadership and governmental theory.
3. There was a belated nationwide recognition that the wastage of soil and water is a genuine menace to the national welfare.

[25] Millard Peck, "Reclamation Projects and Their Relation to Agricultural Depression," *Annals of the American Academy of Political and Social Science,* CXLII (March, 1929), 177–85.

[26] W. G. Hoyt, "Unusual Events and Their Relation to Federal Water Policies," *Transactions of the American Society of Civil Engineers,* LXIX, No. 8, Part II (October, 1943), 290–316.

The concept of secular spending for resource development involves consideration of the long-run needs of the nation as contrasted to the idea of merely offsetting the ups and downs of the economy along whatever course it may follow. The future of public irrigation policy is, of course closely related to any designed effort for giving direction and character to investment in the national economy. With respect to public investment, Hansen and Perloff wrote:

> A positive governmental program looking toward the full, balanced, and efficient use of all resources would stimulate private enterprise and greatly vitalize and invigorate the whole economy. The *planned* and *intensive* development of our resources will open up a new economic frontier.
>
> What is needed in the post-war period is an expansionary program which gives substantial assurance of a continued high level of employment and income and is large enough to be conceived in terms of a decade or more, so that private business can plan its investments on a secure basis. Temporary and sporadic public expenditures will induce little or no private investment. On the other hand, a public developmental program extending over many years and channeled in directions which open private investment outlets can have a profound influence on business investment decisions.[27]

An inventory of public construction needs was outlined by Howenstine in 1948.[28] The information in Table 14 shows that there are ample opportunities for a long-run program of public investment. Howenstine notes that the inventory

> . . . considerably underestimates the amount of public construction that will be needed in the next several decades. Since it measures only the gap between existing facilities and current standards, it makes no provision for expanding needs due to population growth and urbanization. It takes no account of the increasingly large amount of construction that is necessary to maintain and replace existing structures because of depreciation and obsolescence. It makes no allowance for higher standards in public facilities and services which the public is certain to demand as the years go by. Furthermore, it does not cover needs for land development and public services which would certainly be included in any compensatory employment program.[29]

[27] Alvin H. Hansen and Harvey S. Perloff, *Regional Resource Development* National Planning Association, Planning Pamphlet 16, October, 1942, p. 5.

[28] E. Jay Howenstine, Jr., "An Inventory of Public Construction Needs," *The American Economic Review*, XXXVIII, No. 3 (June, 1948), 353–66.

[29] *Ibid.*

TABLE 14

Inventory of Public Construction Needs (1940 Costs)

Type	Dollar Volume (billions)
Transportation	30.20
Education Facilities	7.35
Health Facilities	6.25
Recreational Facilities	7.50
Other Public Buildings	12.15
Regional Development	11.30
Housing	3.00
Rural Electrification	0.25
Total	78.00

Source: Howenstine, *op. cit.*

The concept of long-term public investment assumes an economy that is expanding as to both the quantity and the quality of the goods and services produced. An expansionist economy involves full employment of labor, full utilization of resources, and abundant investment outlets.[30] Irrigation development is an important consideration in all three of these conditions.

Irrigation's Relation to National Security

Agricultural production on irrigated land is less subject to the vicissitudes of weather than is farming on nonirrigated land. Thus, considerable weight might be given to irrigated agriculture as a stable source of food and fiber. Do this and other features of irrigation indicate significant attributes in relation to national security? In noting that agricultural production fell off to very low levels in 1932–36, partly because of severe droughts and partly because of the production control programs, Black points out that production did not catch up with population growth again until 1939.[31] Under more stringent circumstances, such a situation might have had serious consequences with respect to the well-being of the nation. The National Planning Association raised the question as to why

[30] Conrad H. Hammer, "Agriculture in an Expansionist Economy," *Journal of Farm Economics*, XXV, No. 1 (February, 1943), 36–51.

[31] John D. Black, "The Food Supply of the United States," *Annals of the American Academy of Political and Social Science*, CCXXV (January, 1943), 80–82.

new land should be irrigated when we had been concerned with farm surpluses only a few years before and then answered its own question: "Our hope of building a better postwar agriculture rests not on maximum production *at any cost,* but on adequate *planned* production by farmers who have good land, equipment, facilities, credit opportunities, proper income, and fair prices so they do not have to kill themselves and their resources to make a living and perform their social function." The Association goes on to say that new lands are necessary to replace other lands which have been overused and misused.[32] It has been stated, too, that "almost certainly production from *some* present sources cannot continue indefinitely at the level of the five years following World War II." [33]

The growing importance of chemurgy gives added significance to agricultural production beyond that for human food and livestock feed. Salter observed: "This nation's huge industrial machine, the greatest in the world, is leaning more and more on agriculture as a source of raw materials. Soybeans, for example, are the raw materials for more than four hundred manufactured products, ranging from plastics to printing inks." [34] Agricultural raw materials are likely to increase in importance in industry as substitutes for other materials accompany the growing pressure on certain fund resources.

The development of water resources on a multiple-purpose basis achieves the maximum in values during wartime. During such periods, virtually all factors of production—land, labor, capital, and management—are utilized to their maximum potential. As a part of multiple-purpose development, irrigation becomes involved in the broadest possible considerations related to national security. With respect to hydroelectric power development it has, for example, been stated: "The question is not whether public and private power agencies can live together, but whether public and private agencies, working together at top speed, can expand power output fast enough to sustain our dynamic American economy. . . ." [35] The long-run

[32] National Planning Association, *For a Better Post-War Agriculture,* Planning Pamphlet 11, May, 1942, p. 17.

[33] Whitaker and Ackerman, *op. cit.*, p. 460.

[34] Robert M. Salter, "Utilizing Our Soil Resources for Greater Production," *Annals of the American Academy of Political and Social Science,* CCLXXVIII (November, 1951), 179–90.

[35] William E. Warne, "The Government's Program and Aims in Power Development," Address at the Annual Meeting of the Chamber of Commerce of the United States, Washington, D.C., May 2, 1950.

relationships of water power development to natural security are further noted thus: "There are compelling reasons why we should put our rivers to work. Most of the power which energizes America today is produced by drawing upon fund resources we cannot replace. Forty-six million kilowatts of our national capacity are installed in plants which feed upon coal, oil, or gas. Only sixteen million kilowatts of capacity make use of our renewable river resources. . . ." [36]

Questions of what is germane to the national interest become very different where irrigation is a part of multiple-purpose development from where it is a single use of water. The problem is complicated by the fact that federal power policy has been set forth even less definitely by Congress than irrigation policy and is subject to fluctuating political winds.[37]

Multiple-purpose development places the emphasis on the full use of resources. Hines challenged what he termed the dominant American belief that the only "good" resource is a resource in commercial use. He pointed out that different factors are involved in the "full employment" of human resources and in natural resources and wrote, "A man-hour of unemployment is an irretrievable loss to society. When multiplied by millions, as it is during a depression, it becomes an irreparable loss. But a strict identity between waste and disuse does not extend to natural resources." [38] Hines goes on to contend that certain natural resources may require periods of disuse for replenishment. This argument could be used in support of accelerated resource development in order that the usable resource base be broad enough to allow for some resources to be left idle at various times and thus maintain a stable natural resource foundation.

United States Foreign Trade Policies

Public irrigation policies cannot be considered apart from the foreign trade policies of the United States. The high level of living of the American people is based on access to vast and varied re-

[36] *Ibid.*

[37] John W. Haw and F. E. Schmitt, *Report on Federal Reclamation to the Secretary of the Interior, U.S. Department of the Interior* (Washington, D.C.: Government Printing Office, December 1, 1934), pp. 120–26.

[38] L. Gregory Hines, "The Economics of Idle Resources," *Journal of Soil and Water Conservation*, VII, No. 1 (January, 1952), 27–29.

sources through largely unhampered trade among the major regions of the nation. Obviously, similar benefits can accrue to the world at large with a maximum of free trade. It is also obvious that the United States will continue to produce all or part of certain items which can be produced more cheaply abroad, and do so for reasons of national security in a world not yet assured of a peaceful existence.

The nature of foreign trade policies will affect public irrigation policy in at least two important ways: (1) The extent to which we buy goods from other countries will be the determining factor in how much we can export. In addition to exports of agricultural products, a high level of industrial exports will maintain employment and continued large domestic demand for agricultural production. (2) The extent to which we subsidize or protect the production of crops which cannot otherwise compete with foreign production will determine whether or not some crops will be grown at all. In the case of sugar beets, an important cash crop in many irrigated areas, competition with foreign sugar production will be difficult without protection in most areas unless mechanization eliminates the handicap of scarce and expensive field labor.

The United States could produce all the sugar it consumes. Acreage of sugar cane could be doubled in Louisiana and quadrupled in Florida. Sugar beets could be increased tenfold in the Midwest and doubled in most irrigated areas of the West. The people of the United States can take a position between two extremes: (1) full domestic production and high subsidies or (2) a fraction of full production and no subsidies.[39] The position taken will depend to some extent on the prospects for peace in the world.

The Committee on Agricultural Policy of the Association of Land Grant Colleges and Universities recommended expanded international trade. The Committee noted the argument that we cannot afford to expose our high levels of living and high wages to competition of goods from countries with lower levels of living and lower wages. The argument is refuted by the fact that levels of living are far from uniform within the confines of our own nation. Rather than bringing down the higher levels of living, the free flow of trade within the country has enabled all Americans to raise their

[39] John D. Black and Catherine T. Corson, *Sugar: Produce or Import* (Berkeley, Calif.: University of California Press, 1947), p. 2.

level of living.[40] Any major steps toward freer world trade will have to be given proper weight in the formulating of public irrigation policy. The nature and extent of such trade would be an important factor in determining the amount of new irrigated lands to be developed.

[40] Association of Land Grant Colleges and Universities, *Agricultural Policy in Relation to International Cooperation,* Statement of the Committee on Agricultural Policy, July 26, 1946.

CHAPTER 18

Toward a Sound Irrigation Policy

"Expanded Irrigation or Gradual Starvation" is the title of a speech delivered by Senator Elmer Thomas of Oklahoma on October 10, 1946. He was speaking at the annual convention of the National Reclamation Association in Omaha, Nebraska. "More Agricultural Surplus?—Sure" is the title of an article opposing further irrigation development, by Edson Abel of the California Farm Bureau Federation. He was writing in the September, 1946, issue of *The Nation's Agriculture*.

These are only two of many speeches and articles regarding the future of irrigation development in the United States. They are referred to here because they represent extreme opposites in point of view and because they appeared almost simultaneously. Many other expressions of opinion could be quoted, representing the complete range between the two.

It is obvious that both viewpoints cannot be correct. A number of speakers and writers on the subject of irrigation development have said that "reclamation is at the crossroads." It is evident that there are almost as many ideas as points on the compass regarding which road the nation should travel from the crossroads. The diversity of opinion as to what our national policy should be with regard to land reclamation is colored by many factors including sectional interest, political expediency, and promotional pressures. As a nation, we should be mature enough to map out a long-range policy regarding land reclamation which will assure the continued strength of the nation and be acceptable to most of its citizens. This implies a policy based on a consideration of all factors affecting the nation's need for land resources, not two or three which paint a particular picture. It has no doubt been noted that, up to this point, the writer has not attempted to offer conclusive answers to questions affecting public irrigation policy. To have done so, before all the evidence was presented, would have meant basing conclusions upon

only a part of the factors involved in a full consideration of irrigation development. We are now in a position to view the development of the water resources of the United States on a proper basis, i.e., as a problem of national scope and interest.

Determinants for Irrigation Policy

Fourteen factors have been discussed which, in the opinion of the writer, should be considered in formulating public irrigation policy. By way of summary, they are:

1. National population growth
2. Western population growth
3. Higher levels of nutrition
4. Food and feed reserves
5. Rehabilitation of man-abused lands
6. Alternatives in new land reclamation
7. Regional adjustments in agriculture
8. Technology in agricultural production
9. Irrigation and farming opportunities
10. Irrigation in the western economy
11. Industrial development of the West
12. Irrigation and the business cycle
13. Irrigation's relation to national security
14. United States foreign trade policies

The first four of these factors are concerned with the demand for agricultural production and the next four have to do with the supply of agricultural products. The last six factors may be related directly or indirectly either to the demand for or the supply of food and fiber and are affected in considerable measure by social goals, philosophies of government, and the pressures of various segments of the society.

A public irrigation policy giving objective study to these fourteen factors and placing each of them in its proper perspective should be more nearly in the public interest at all levels than public policy on irrigation has been in the past. It is obvious, of course, that some of these factors will be difficult to balance against other factors on the list. In the past, policy has taken into consideration only one or a few of the fourteen factors. As a result, the United States has never had a consistent national policy for irrigation development. The

most convenient and best selling arguments have been used from time to time. Such an opportunistic approach has largely eliminated long-run goals from public action. Policy has borne little relationship to the needs of the nation.

Planning for Irrigation Development

Inherent in the concept of formulating irrigation policy—on the basis of all relevant factors and with a view to the long-run needs of the nation—is the necessity for providing direction to the course of public action. As soon as public policy is oriented to well-defined goals, we discard the long-existing procedure of policy-making on the basis of short-run expedients and substitute an orderly process of deciding what in the long run is in the best interest of a majority of the people. We have entered the realm of "national planning."

Planning has objectionable connotations to a considerable segment of the public when the idea is applied to governmental activity. This is somewhat surprising in view of the fact that man insists on planning his activities and those of the immediate groups to which he belongs. With the exception of matters of daily routine, man does few things without considering alternative means and ends. In fact, man is usually planning better ways to carry on his daily routine, too. It seems inconsistent, then, that man should question the planning of public courses of action. Indeed, one might expect man to insist on such planning.

Why do many Americans, who would consider an individual a "poor manager" if he did not plan his personal activities, take the view that there is something basically wrong with planning public action? Possibly the answer is to be found in the fact that most persons seem to assume that public planning must necessarily be political planning, i.e., planning which has as its goal a change in the form of government. This popular view of the nature of planning is very different from national planning for the orderly development and conservation of resources. It should be recognized, however, that the political aspects are difficult, if not impossible, to eliminate completely from any program of planning. The fact that public action must in some manner be administered suggests why planning for the most nonpolitical of goals will invariably have some political ramifications.

Contrary to the popular view that national planning must be detrimental to our democratic system of government, it may be essential to the continued strength of the American system. A nation which does not look to its future needs for resources and plan for their use in the public interest is likely to find itself in difficulty. History indicates that nations which deplete their resources are more likely to become involved in changes in government, or to disappear entirely, than are those which maintain a stable resource base.

Most of the development and use of natural resources in the United States has been without benefit of long-range national planning. The future of the nation may be closely related, however, to the orderly development and use of less plentiful resources. National planning for the development and use of irrigation resources is an important phase of the total problem of assuring adequate supplies of food and fiber for a growing population.

Components of a Sound Irrigation Policy

At this point, and as a conclusion to this study, some of the components of a sound irrigation policy for the United States are suggested. They are not presented as being all-inclusive but are those which appear important to the writer.

1. *Population trends in the United States indicate that a reappraisal of the nation's food and fiber needs is in order.* There is no question regarding the ability of the nation to feed and clothe its growing population, and at a higher level than that now existing. There is a question of great national interest as to where and how the needed increase in agricultural production may best be secured.

2. *The development of some new lands may be necessary to the increased efficiency of some segments of agriculture.* It is possible that technological advance will result in increases in production on existing lands sufficient to fill the increased demands for agricultural products. In order to realize the full potentiality of some technological developments, however, less desirable lands now being farmed may need to be replaced by new lands better adapted to technology.

3. *The improvement of lands through irrigation results in increased production based on utilization of a flow resource.* Some

of the technological applications which may be made to land to increase agricultural production are based, directly or indirectly, on fund resources which may become more scarce and more expensive as time goes on. Properly developed and maintained, the application of water to land provides a basis for increased production which can be maintained indefinitely.

4. *The long-run water requirements for agricultural lands must be considered now in the allocation of water resources among multiple uses.* The increasing competition for available water for all purposes will result in early commitment of most supplies. Once water has been allocated to a particular purpose, it will be extremely difficult to divert it to another use which might become more desirable. Difficulty in changing the use of water is associated with both physical factors and the institutional factors growing up around legal rights to water.

5. *The family farm should remain as a basic objective in the expenditure of public funds for irrigation development but it should be a concept consistent with modern agriculture.* The combination of resources which can be managed efficiently by the farm family has changed through the years. If an obsolete standard for the family farm is maintained in connection with public irrigation development it may result in the creation of a segment of agriculture which is at a competitive disadvantage not only with highly commercialized agriculture but with other family farms as well.

6. *There is both a public and a private interest in not having public resources and funds tied up without full return in the early years on new irrigation projects.* A greater degree of development before settlement, particularly in the preparation of land to receive water, should be incorporated in public irrigation policy. Consideration should be given to all means by which the settler can secure control of the resources necessary to speed development of farm units during the early years of the project. Adapted credit should be made available and leasing should be more acceptable in the early stages of settlement. Public land purchase should be considered as a means for reorganizing land resources. When viewed as a means to achieve an end and not as an end in itself, public land purchase might have greater public acceptance.

7. *The relation of irrigation to the best utilization of the other resources of the arid and semiarid region should be accorded proper*

recognition in the formulation of public policy. For a great many years, the production of each irrigated farm in the western states was considered as representing the total benefit accruing, in the same way that each farm in the humid region must stand alone as to production. Actually, the irrigated farm can often take credit for some of the production on surrounding range lands which, if they had to stand alone, would be utilized less efficiently or not at all.

8. *The national security would be best served by expansion of the agricultural economy to provide sufficient elasticity to take care of emergency periods.* In general, the accumulation of food and feed reserves for periods of national emergency is less desirable than the development of an agricultural economy with the flexibility to meet the demands of such emergencies. Irrigation can make major contributions to the emergency expansion of agricultural production.

9. *Public policy guiding the expenditure of public funds for land reclamation should consider all the alternatives for improving and expanding the land base.* Such policy formulation should consider not only the immediate comparisons of returns per dollar of public funds to be spent on the alternatives but also the implications of maintaining a sound, balanced agriculture throughout the entire area of the nation. A maladjusted resource base in any area may involve significant social costs over a period of time and weaken the national economy.

10. *In choosing among alternative opportunities for land reclamation and among alternative irrigation developments, due consideration should be given to extramarket values.* Extramarket values, often referred to as intangibles or indirect benefits, should be the determining factor in choosing among alternative projects and programs in cases where a clear-cut decision is not obvious on the basis of market values alone.

11. *The reimbursement base for irrigation should be broadened to include all market values from development whether accruing on farms or in the nonagricultural segment of the local economy.* The inclusion of other local beneficiaries, in addition to farmers, in the repayment program will serve to raise the level of local responsibility and reduce the promotional aspects of irrigation development.

12. *The rehabilitation of deteriorating irrigation systems and the providing of supplemental water for projects with an inadequate supply should be an important aim of public irrigation policy.* Full costs including interest should be assessed against those lands receiving supplemental water and which are in excess of the 160-acre limitation or such other family farm standard as may be in effect on the particular project.

13. *The participation of the states in water resource development might well be increased through the establishment of state planning and construction agencies.* Developments for which the costs and benefits are of local concern should be given particular consideration for state rather than federal action. Public benefits from state developments which accrue beyond state lines could be assumed by the federal government on a basis of matching funds similar to the procedure used in providing federal funds for highway construction in the states or through reimbursement to the states based on calculation of the benefits.

14. *The United States can no longer afford to be prodigal with her resources or inefficient in their use.* National planning for the future can be consistent with a democratic society. It is necessary that the United States find means of carrying on an adequate amount of planning for the future and do it within the framework of democratic government if that society is to survive.

15. *There should be more local participation in the development of public resource policy.* The past twenty years have contributed to a state of mind in which local people expect to be told by government what the policies are to be rather than to take a hand in the formulation of policies. This may be associated with the fact that people generally have failed to recognize that their interests in public resource policy go beyond local issues and local problems.

16. *Public expenditures for resource development, including irrigation, should be set aside from other sections of government budgets.* There is a tendency in the public mind to lump spending for the development of the nation's productive resources with other types of government spending. Government spending which is productive in itself, or which creates opportunities for private enterprise to expand production, is vastly different from spending for the day to day housekeeping functions of government. A proposal of several years ago to present a divided budget to the federal con-

gress was labeled as a subterfuge designed to make it appear that the government was operating on a balanced budget when such was not the case. On the contrary, the separation of investment items from costs of current government operations would force the public and its elected representatives to make some highly important and desirable decisions on the improvement and development of the nation's resources. No clear-cut decisions are made now because investment and operating items are intermixed.

17. *Irrigation development should be considered in the formulation of public policies designed to serve as countercyclical measures.* The situation with respect to employment levels should not be the sole determining factor, however, in whether or not public expenditures are to be made for irrigation development. It should be recognized that countercyclical measures related to monetary policy may be more effective than expenditures for resource development in providing an offset for depression conditions.

18. *Public policy with respect to irrigation development should be consistent with foreign trade policies of the United States.* Agricultural production and resource use should fit into the framework of increasingly greater freedom of world trade while recognizing that completely free trade is impossible in a world not at peace.

19. *Public expenditure for resource development, including irrigation, is consistent with the traditional national policy of making investments in the productive capacity of the nation.* In the past, it has been done through land grants to individuals, business organizations, and the states, and through subsidy of "infant industries" by means of tariffs and tax concessions. These expenditures of the public's capital never showed in the nation's system of bookkeeping, but, if a fair value were placed on these investments in resource development, they might compare favorably with the cash investments appropriated from the federal treasury at the present time.

20. *Irrigation development can no longer be viewed as a problem separate from other phases of resource development.* It must be viewed in its proper perspective as a part of a national program of land reclamation and as an integral part of multiple-use development of water resources.

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